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Permanent Secretary Denison Scientific Association

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# SILURIAN CYRTOCONIC CEPHALOPODS FROM OHIO, ONTARIO, AND OTHER AREAS

AUG. F. FOERSTE

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#### NOTES ON SILURIAN STRATIGRAPHY

The Cedarville dolomite is exposed typically in southwestern Ohio in the area extending from Springfield southward to Yellow Springs, Cedarville, Port William, and Wilmington. Westward it occurs as far as Greenville. Within this area the Cedarville dolomite contains a fauna closely similar to that of the Racine of southeastern Wisconsin and the adjacent part of Illinois.

The Cedarville fauna does not occur in the northwestern part of Ohio. However, in the area south of Toledo, at Genoa, Bowling Green, and Rising Sun, the strata contain *Megalomus*, *Monomerella*, *Trimerella*, and other fossils indicating the presence of the overlying Guelph dolomite. *Megalomus* and *Monomerella* occur also in southeastern Wisconsin in strata lithologically similar to the underlying Racine but containing a Guelph fauna.

In southwestern Ohio the typical Cedarville fauna has not been traced farther south than Wilmington. However, a typical

Guelph fauna, including *Goniophora*, *Megalomus*, *Monomerella*, *Trimerella*, and other fossils, occurs in the upper part of the Peebles dolomite in the area between Hillsboro and Bainbridge and thence south through Highland and Adams counties to the Ohio River. It is possible that the lower part of the Peebles dolomite corresponds stratigraphically to the Cedarville dolomite, but this can not be determined at present since the fauna in this lower part of the Peebles formation is different from that in the typical Cedarville.

*Megalomus* is not known in the Huntington dolomite of northern Indiana, but the presence of *Pycnostylus* and *Monomerella* suggests affinities with the Guelph, though a considerable part of this Huntingdon fauna has a Racine facies. The underlying Liston Creek fauna has much in common with the Huntingdon fauna, especially with that part which has a Racine facies. Ten species of cephalopods are listed by Cumings and Schrock as occurring both in the Liston Creek and in the Huntingdon.

In the northwestern part of Illinois, in Rock Island county, the Port Byron fauna (1) has a Racine facies, and its stratigraphical position appears to be similar, but among the numerous species of cephalopods found in the Port Byron dolomite few are identical with those found in the typical Racine of southeastern Wisconsin. Possibly this is explained by the presence of the Guelph species *Monomerella prisca*, *Trimerella acuminata*, and *Trimerella ohioensis*, all listed by Hall and Clarke from Port Byron.

In Iowa the strata equivalent to the Port Byron dolomite apparently were included in the upper part of the Hopkinton dolomite. However, several distinguishable horizons evidently are included in the Hopkinton, and that horizon in the lower Hopkinton which contains *Huronina* and *Kayoceras* apparently corresponds approximately to the Manistique formation of northern Michigan and Lake Timiskaming farther eastward.

Just where the Manistique belongs in the stratigraphic sequence of the various Niagaran formations at present known in north-central North America still is in doubt. Williams (2) cites *Huronina vertebralis* from the upper part of the Lockport dolomite at South Bay, near the eastern end of Manitoulin island. In

Anticosti only *Huronina obliqua* is known from the middle part of the Jupiter formation, but *Huronina obliqua*, *Huronina vertebralis*, and *Huronina chicottense* occur in the overlying Chicotte (3). Ulrich includes both the Jupiter and the Chicotte in the upper Clinton, including under this term the Irondequoit and Rochester of New York. It is possible, of course, that *Huronina* occurs both in the Clinton and in the Lockport, but the preponderance of evidence at present is in favor of the Clinton.

In earlier studies of the Niagaran of New York the Guelph dolomite was regarded as a formation distinct from the Lockport dolomite and as overlying the latter. However, in the vicinity of Shelby, south of Medina, in western New York, Clarke and Ruedemann discovered two horizons in the upper part of the Lockport which contain species suggesting Guelph relationship. The lower horizon is 3 feet thick, occurs 62 feet over the base of the Lockport, and contains *Monomerella noveboracum*, a species closely related to *Monomerella prisca*, and originally described from the Guelph of Ontario. The upper horizon is 8 to 10 feet thick, occurs 32 feet above the lower horizon, and in the Rochester area contains the species described by Hall as *Cyrtoceras arcticameratum*, also from the Guelph of Canada. Neither horizon contains *Megalomus*. Some of the associated species have a Racine aspect. Exactly what relationship these two horizons in the Shelby and Rochester areas have with the typical Guelph of Ontario has not yet been determined.

In southwestern Ohio the porous, poorly stratified Cedarville dolomite is underlaid in descending order by the dense and well bedded Springfield dolomite, and the massive, porous, and more or less mottled *Euphemia* dolomite. Near Cedarville this series is underlaid by a shaly clay exposed for a thickness of almost 6 feet, closely resembling the Waldron clay lithologically, and containing a typical Waldron fauna (4).

Waldron fossils were found also in the eastern part of Muncie, Indiana, in the lower part of the quarry west of the White River, near the former location of the Wire Works. Here they occur in a clay shale a foot and a half thick, occurring 45 feet below the level of the railroad following the western side of the river (5).

The rock at this point is mapped by Cumings and Schrock as Liston Creek limestone.

Horizons within the Liston Creek formation containing fossils suggesting Waldron affinities are recorded by Cumings and Schrock (6) also from other localities in east-central Indiana. The most important of these is that at Marion. Here a shaly layer, in the midst of cherty limestones, contains bryozoans and brachiopods of Waldron affinities. At Ingalls, 10 miles southwest of Anderson, a blue limy shale half a foot thick contains an abundance of bryozoans and small brachiopods of Waldron affinities. At Huntingdon, in the midst of the Liston Creek formation, there is an argillaceous bed several feet thick which is similar to certain phases of the Waldron.

At Muncie an attempt was made to discriminate the fauna found beneath the Waldron-like clay horizon from that occurring above, but without illuminating results.

The Dayton limestone of southwestern Ohio is correlated provisionally with the Reynales limestone in the Lower Clinton of New York. It is most fossiliferous in the area extending from Lynchburg, in the northwestern margin of Highland county, southward through Highland and Adams counties, into Lewis county, Kentucky. Here it is chiefly a coral fauna, but *Pentamerus peeblesensis* Foerste (?) is abundant locally. This fauna may be traced northward as far as Dayton on the eastern side of the Miami valley. West of this valley, however, corals are rare and small brachiopoda become more common.

In southern Indiana it is assumed that the thin limestone layer, often less than a foot thick, underlying the typical Osgood clay, corresponds to the Dayton limestone. However, this thin limestone layer has never been traced northward into the area occupied by the typical Dayton limestone, chiefly owing to the absence of suitable exposures over large intermediate areas.

#### DIFFICULTIES IN CORRELATION

Within the same geologic province the lithologic characteristics of different stratigraphic units often change so little horizontally that their correlation in different sections presents no difficulty.

Moreover, within the same province the characteristics of diagnostic species frequently change so little, at least at the same horizon, that correlation by their means is relatively simple. Of course, this presupposes that variations in form of the so-called long-ranging species at different horizons have been carefully discriminated, and, if not supplied with distinctive names, are at least recognized. In this sense, a geologic province is one within which both the lithologic and the faunal elements are relatively constant at the same horizon.

A second province, presenting a closely similar faunal facies, usually is recognized as distinct from the first only when close study reveals that forms closely similar to those in the first province can be discriminated from the latter on close study. In practice, it is of no importance whether the distinct forms in the second province are given new names as species or varieties or are not named separately at all, as long as these differences are kept in mind by the person correlating. Of course, correlations based not on personal knowledge of the faunas but on lists of fossils collected from literature can not have greater value than the original sources on which these lists are founded.

Frequently faunal differences in adjacent provinces are accompanied by corresponding differences in their lithological character. This does not mean necessarily that a limestone in one province is replaced by shale or sandstone in another. Limestone may occur in both provinces at approximately the same horizon, but these limestones may be distinguishable in color, bedding, coarseness of grain, percentage of clastic material included, or by differences in chemical constitution.

Perhaps the most common source of error in correlation is the assumption that a similar lithologic succession of geologic units in adjacent provinces predicates the equivalence of similar units in a general stratigraphic scale.

Correlations based on similar facies, in other words on general resemblances between faunas in different provinces, usually have the least value, because rarely based on discriminating study of differences frequently to be noted in those species assumed to be common to both provinces, especially in the case of the long ranging species.

Correlation by calculating the percentage of species in a particular formation in one province regarded as occurring also in each of a number of formations in another province may appear more exact until it is realized that usually such percentages are based on indiscriminating lists including long ranged species whose variations at different horizons are ignored, and also species regarded as common to both provinces because not studied by closely comparative methods. In fact, the first step toward an accurate correlation between the strata occurring in different provinces is the exclusion of all those species known not to have been studied in sufficient detail.

The difficulties of correlation when based on lists largely made up of loosely identified species is illustrated by the common appearance of such names as *Atrypa reticularis*, *Dalmanella elegantula*, *Leptaena rhomboidalis*, *Pentamerus oblongus*, *Rhipidomella hybrida*, and *Schuchertella subplana* at all sorts of horizons in the Silurian, especially in view of the fact that one of the forms usually assigned to *Pentamerus oblongus* is even of distinct generic value. Moreover, *Dinorthis subquadrata*, originally described from the middle Richmond of Ohio is represented by an almost identical form from the upper Trenton of Kentucky, with no representative from intermediate horizons known at present. Such occurrences are familiar to all paleontologists.

In view of these facts it is evident that correlation by means of the occurrence of particular genera supposed to be diagnostic of particular horizons, such as *Huronia*, *Megalomus*, *Monomerella*, and *Trimerella*, are likely to be in error, since later studies may prove a longer vertical range than at present suspected. This possibility of error is recognized in the correlations attempted by means of the presence of these genera in the various formations discussed in the present paper.

At present the most accurate correlations are based on the most accurately studied species. A few species accurately studied are of greater value than a much larger number loosely identified. However, all species are not likely to prove of equal value, even after careful study. Those that belong to smooth forms, like *Lingula* and *Proetus*, especially when closely similar in form or general outline, are less likely to be discriminated accurately

than those whose surfaces or outlines are conspicuously granular or spinose, since granules and spines often show differences in size, form and arrangement, and even genal angles of the heads of trilobites often vary in relative length, curvature, and rate of tapering.

Where differences in lithology of the enclosing strata come in there may be corresponding differences in their faunal content. This is familiar to any one studying marine faunas along our present oceanic shores. Corresponding differences in faunal content may be recognized in tracing faunas from more calcareous strata toward their more arenaceous representatives. Fortunately, marine faunas often are carried by currents far from their natural habitats, especially during great storms, so that forms characteristic of deeper waters may intermingle with those more commonly found on muddy or sandy bottoms. Here, again, it is only those species found in both areas which have been subjected to the closest study which are likely to give the best results in correlation.

#### THE CEDARVILLE FAUNA AT WILMINGTON, OHIO

The present paper continues the study of cephalopods found in the Cedarville dolomite in the Moodie quarry along the southeastern margin of Wilmington, Ohio, between 40 and 50 years ago by two local doctors who were greatly interested in fossils. The collection made by Dr. George M. Austin was donated by him to the U. S. National Museum; that by Dr. L. D. Welch is deposited in Wilmington College. Altogether 37 species of cephalopods were studied from this single locality. Of these, 23 species were described in earlier publications of this Journal.

The following is a list of the cephalopods found in the Cedarville dolomite at Wilmington, Ohio. In the case of those species described in former volumes of this Journal, the number of this volume is indicated in brackets.

*Orthoceras alienoides* (23)  
*Orthoceras moodiense* (23)  
*Orthoceras penecillum* (23)  
*Orthoceras whitfieldi* (23)

*Orthoceras wilmingtongenense* (23)  
*Cycloceras austini* (23)  
*Cycloceras junciforme* (23)  
*Dawsonoceras hyatti* (23)

Metaspyroceras ruedemanni (23, 27)	Uranoceras perdistensum
Kionoceras austini (23)	Ophidioceras wilmingtense (25)
Kionoceras myrice (23)	Lechritrochoceras lentidilatatum (25)
Elrodoceras sp. Wilmington (23)	Graftonoceras orton (21)
Cyrtorizoceras falseiforme	Nautilus wilmingtense (25)
Cyrtorizoceras fosteri (25)	Phragmoceras colliciare (24)
Ekwanoceras austini	Phragmoceras cuneiforme (24)
Worthenoceras subfusiforme	Phragmoceras parvum (24)
Austinoceras turgidulum	Phragmoceras wilmingtense (24)
Euryrizoceras anguloseptatum	Mandaloceras austini
Euryrizoceras percurvatum	Hexameroceras hertzeri (24)
Ectocyrtoceras wilmingtense	Hexameroceras compressum (24, 25)
Ectocyrtoceras gibberosum	Stenogomphoceras ignotum
Amphicyrtoceras welchi	Stenogomphoceras sp. Wilmington
Rhomboceras welchi	

Two species of cephalopods are described here from the Cedarville dolomite at Cedarville and Yellow Springs, Ohio; two species are from the Dayton limestone of southwestern Ohio, and three are from the lower part of the Peebles dolomite in the Trimble quarry, at Hillsboro, Ohio. The species now known from this quarry are *Amphicyrtoceras bownockeri*, *Amphicyrtoceras tantalum* (20), *Grimsbyoceras genuiflexum*, *Grimsbyoceras hillsboroense*, and *Phragmoceras hillsboroense* (24), two of which were described in earlier numbers of this Journal, as indicated by the numbers here inserted in brackets. *Pentameroceras mirum* (24) and an unnamed species of *Phragmoceras* (24) were described from a higher elevation in the Peebles dolomite from a locality north-east of Peebles, Ohio. *Phragmoceras ellipticum* was described by Hall and Whitfield as associated with *Trimerella ohioensis*, and therefore came from the Guelph part of the Peebles dolomite.

#### THE HOPKINTON OF IOWA

Prof. A. O. Thomas described from the Hopkinton division of the Silurian in northeastern Iowa a number of siphuncles of cephalopods under the names *Huronia vertebralis* Stokes, *Huronia obliqua* Stokes, *Huronia subcylindrica* Thomas, *Huronia hopkintonensis* Thomas, *Huronia turbinata* Stokes, *Discosorus* (?) *biconoideus* Thomas, and *Actinoceras* cf. *richardsoni* Stokes. In the present paper the two specimens described under *Discosorus biconoideus* are referred to *Kayoceras*, one becoming the genotype.

The specimen compared with *Armenoceras richardsoni* (Stokes) apparently is a *Huroniella*. The assemblage, if coming from approximately the same beds, suggests the presence of an horizon corresponding to the Manistique formation of northern Michigan and corresponding strata in the Lake Timiskaming area, while the Port Byron formation, typically exposed at Port Byron, Illinois, directly east of Le Claire, in Scott county, Iowa, is more nearly related to the Racine of southeastern Wisconsin and the adjacent part of Illinois, or may even belong to the Guelph, judging from the presence of *Monomerella prisca*, *Trimerella acuminata*, and *Trimerella ohioensis* at Port Byron, Illinois (8).

#### THE LOCKPORT OF THE GRIMSBY AREA

In his Catalogues of the Silurian Fossils of the island of Anticosti (1866) Billings described 13 species of cephalopods from the township of Grimsby, southeast of Hamilton, Ontario. These species had been collected by Johnson Pettit "from a formation difficult to work out." In Bassler's Bibliographic Index of American Ordovician and Silurian Fossils this formation is identified as Lockport. Why *Apiocystites canadensis* Billings, collected by Pettit from the same locality, and presumably from the same horizon, there was referred to the Rochester member of the Clinton is unknown. The cephalopods were described under the following names:

Orthoceras Oberon	Cyrtoceras Corydon
Cadmus	Clitus
Brontes	Oncoceras Teucer
Pylades	Pettiti
Varro	Thales
Remus	Streptoceras Janus
(annulatum)	Heros

The species *Orthoceras annulatum* Sowerby is mentioned in the description of *Orthoceras Cadmus* as occurring with the latter.

The cyrtoconic species of the preceding list are redescribed in the present paper; however, all of the types of the orthoconic species have been lost so that our knowledge of these is confined to the data recorded in the original descriptions by Billings.

Three of these orthoconic species, namely *Orthoceras brontes*, *Orthoceras pylades*, and *Orthoceras remus*, are retained provisionally under the generic name *Orthoceras* used in its broader sense.

The species *Orthoceras oberon* was founded on three specimens. At least one of these (the one stated to have annulations with one edge abruptly elevated, giving it a sub-imbricated aspect) was a typical form of *Geisonoceras*. There is a possibility that one of the other two specimens (the one described as having the annulations regularly convex) may have been a weakly annulated form of *Cycloceras*, but this can not be affirmed definitely in view of Billings's statement that the annulations of this species are somewhat variable in form in the same specimen.

The annulated species *Orthoceras varro* may be a *Cycloceras*, but this can not be affirmed definitely in the absence of any knowledge of the ornamentation of the surface of the shell, aside from its annulation.

*Orthoceras cadmus* belongs to that division of the genus *Kionoceras* in which the vertical furrows are cancellated by numerous fine transverse striae and less distinct vertical ones. The reference of this species to *Orthoceras cancellatum* of Hall, later designated by him as *Orthoceras subcancellatum*, must not be taken too seriously, since in the latter species the transverse striae are no more prominent than the vertical ones, though less numerous. The associated species *Orthoceras annulatum* Sowerby evidently was some form of *Dawsonoceras*.

In his original description Billings stated that *Orthoceras oberon* may be *Orthoceras imbricatum* Hall of volume 2 of the *Palaeontology of New York*, and that *Orthoceras cadmus* appears to be *Orthoceras cancellatum* Hall. *Orthoceras annulatum* Sowerby he indicated as synonymous with *Orthoceras undulatum* Hall in the same volume of the *Palaeontology of New York*. It should be remembered, however, that the cephalopods cited from the *Palaeontology of New York* came from the Rochester formation, while those described by Billings not only came from the Lockport, but apparently from the upper part of the Lockport, and it has not yet been proved that any of the typical Rochester cephalopods occur also in the Lockport.

For the *Orthoceras imbricatum* of Hall the name *Geisonoceras rochesterense* was proposed by Foerste [Jour. Sci. Lab. Denison Univ., vol. 23, p. 254, pl. 53, fig. 1 (1928)]. For *Orthoceras cancellatum* of Hall the name *Orthoceras subcancellatum* (now *Kionoceras*) was substituted by Hall in Miller's American Palaeozoic Fossils, p. 245, in 1877. The Rochester species described by Hall under the name *Orthoceras undulatum* was referred by Foerste [Jour. Sci. Lab. Denison Univ., vol. 23, p. 35 (1928)] to *Dawsonoceras americanum* (Foord), which, as far as known, is confined to the Rochester formation and its western equivalent, the Osgood formation.

The cyrtoconic species described by Billings are here described under the generic names *Amphicyrtoceras*, *Ectocyrtoceras*, *Grimsbyoceras*, and *Streptoceras*.

Four species are described here from the Guelph in various parts of southern Ontario; namely *Amphicyrtoceras williamsi*, *Cyrtorizoceras williamsi*, *Galtoceras arcticameratum*, and *Grimsbyoceras* (?) *orodes*.

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#### CYRTORIZOCERAS Hyatt

Genotype: *Cyrtoceras minneapolis* Clarke. Geol. Minnesota, vol. 3, pt. 2, p. 808, pl. 59, figs. 1-6. For generic reference see Hyatt, in Zittel-Eastman's Text-book of Paleontology, p. 529, 1900.

Breviconic cyrtocones, laterally compressed, living chambers

not contracted toward the aperture, at least not conspicuously. Sutures of septa curving downward laterally, forming broad lateral lobes and distinctly narrow dorsal and ventral saddles, the latter being much more conspicuous. The siphuncle is located close to the ventral wall of the conch, and its segments are fusiform, narrowing downward. The surface of the shell of the genotype is transversely striated and not annulated, but forms with oblique ribs, indicating the former presence of a deep hyponomic sinus, also occur.

Unfortunately, the genotype selected by Hyatt eventually may turn out to be an immature specimen of *Beloitoceras* in which the living chamber had not yet reached its gerontic stage in which this chamber contracts slightly toward the aperture, especially laterally.

The Ordovician forms are all without transverse ribs, but among the Silurian species at present referred to this genus ribbing occurs occasionally on the surface of the shell, while much less in evidence or even altogether absent on casts of the interior of the conch.

#### 1. *Cyrtorizoceras cedarvillense* new species

*Plate 29, figure 5*

The holotype consists of the living chamber and of the impression in the matrix of this living chamber and also of a considerable part of the underlying phragmacone. Its total length in a direct line is 52 millimeters. The conch is laterally compressed and but moderately curved lengthwise, especially along its dorsal side. The cast of the interior of the living chamber is contracted just beneath the aperture. Its length along its convex ventral outline equals 55 millimeters, 21 millimeters of this length belonging to the living chamber. Along the phragmacone and the lower half of the living chamber the radius of curvature of its convex ventral outline is about 100 millimeters, changing to 30 millimeters along the upper part of this chamber. The depth of its concave dorsal curvature only slightly exceeds 1 millimeter as far as midheight of the living chamber. The upper 8 millimeters

of this chamber contract distinctly beneath the aperture. The dorsoventral diameter of the specimen enlarges from 5.5 millimeters at its base to 19 millimeters at midheight of the living chamber and then contracts to 17.5 millimeters at the aperture. The maximum lateral diameter at midheight of the living chamber is estimated at 17.5 millimeters. The suture of the septum at the base of the living chamber curves slightly downward laterally but rises at an angle of about 16 degrees in a ventrad direction. The concavity of this septum equals 4 millimeters, its maximum being located about one third of the dorsoventral diameter from the dorsal wall of the conch. The siphuncle is not preserved but is assumed to be located near the ventral wall of the latter. No trace of surface ornamentation of the shell is preserved, the shell apparently being smooth.

Occurrence: Cedarville, Ohio; from the Cedarville dolomite. U. S. National Museum, no. 81924.

Remarks.—This species is characterized chiefly by its relatively small curvature lengthwise, especially along its dorsal outline. The absence of transverse ribs appears to be another characteristic.

## 2. *Cyrtorizoceras curvicameratum* Clarke and Ruedemann

1903. *Cyrtorizoceras curvicameratum* Clarke and Ruedemann.

Guelph Fauna in the State of New York, memoir 5, p. 90, pl. 17, figs. 1-10.

This species evidently is congeneric with those Silurian forms here referred to *Cyrtorizoceras*, although the cast of the interior of the conch shows no trace of transverse ribbing. On the other hand, the vertical ribbing of the dorsal side of this species is unknown in the Silurian forms here figured. This feature probably is confined to the interior of the shell and is unknown on the surface of the latter. From the Lower Guelph horizon at Shelby, New York. New York State Museum, nos. 5119-5121.

## 3. *Cyrtorizoceras falciforme* new species

Plate 29, figures 1 A, B, C

Conchs laterally compressed, curving strongly lengthwise, expanding rapidly toward the aperture, especially dorsoventrally.

The largest specimen at hand retains 30 camerae. The radius of curvature of its convex ventral outline equals 30 millimeters at the base of the specimen, changes to 40 millimeters for the greater part of its length, and enlarges to 50 millimeters at its top. Its dorsoventral diameter enlarges from 13 millimeters at 80 millimeters below the base of the living chamber to 34 millimeters at this base. In one specimen, with a dorsoventral diameter of 35 millimeters at the base of the living chamber, the lateral diameter is 27 millimeters. The conch not only is strongly compressed laterally but its lateral sides are distinctly flattened. The sutures of the septa curve slightly downward laterally. In a dorsad direction they rise only slightly, but more strongly ventrally, tending to curve outward here, resulting in a slightly sigmoid curvature. The siphuncle enlarges slightly within the camerae, its segments being subfusiform. Immediately beneath the living chamber it attains a diameter of 2.5 millimeters, its nearest side being 2.5 millimeters from the ventral wall of the conch. On the ventral side of the cast of the interior of the conch the sutures are crossed diagonally by faint but regularly spaced transverse ribs, these ribs being most distinct ventrally, becoming faint laterally, and usually disappearing altogether dorsally. Dorsolaterally these ribs are nearly horizontal, but ventrolaterally they curve increasingly downward, crossing the sutures here at angles of about 45 degrees. Immediately beneath the living chamber the crests of these ribs are from 3 to 4 millimeters distant from each other. Only casts of the interior of the conch are at hand. On the surface of the shell these ribs may have been more prominent. The living chamber is 25 millimeters long. On casts of its interior there is a transverse groove between 5 and 8 millimeters beneath the aperture, indicating the presence of a corresponding annular thickening on the inner surface of the shell.

Occurrence: Wilmington, Ohio, in the Moodie quarry; from the Cedarville dolomite.

Wilmington College, in the collection of Dr. L. D. Welch; the originals of figures 1A and 1B.

U. S. National Museum, No. 82172A, figure 1 C.

4. *Cyrtorizoceras fosteri* (Hall)*Plate 29, figures 4 A, B*

1868. *Cyrtoceras fosteri* Hall, 20th Rep. New York State Cab. Nat. Hist., page 349, pl. 16, figs. 11-13.

1930. *Cyrtorizoceras fosteri* Foerste. Jour. Sci. Lab. Denison Univ., vol. 25, p. 28, pl. 4, figs. 3, 4; pl. 8, fig. 3; text fig. 1 on p. 29.

The largest specimen found in the Moodie quarry at Wilmington, Ohio, retains 72 millimeters of the length of the phragmacone, above which the living chamber is preserved for an additional length of 16 millimeters, the original length of this chamber probably being 20 millimeters. The radius of curvature of its convex ventral outline increases from 30 millimeters along the lower third of its length to 60 millimeters along its upper half. The dorsoventral diameter of the conch enlarges from 8 millimeters at its base to 23 millimeters at the base of the living chamber. Nine camerae occur within a corresponding length along the ventral outline of the upper part of the phragmacone. The sutures of the septa curve moderately downward and rise a little higher ventrally than dorsally.

A second specimen retains the living chamber and 7 of the camerae. The shorter length of the upper two camerae indicates that the conch had attained its gerontic stage of growth. The living chamber is 20 millimeters long. It enlarges dorsoventrally from a diameter of 23.5 millimeters at its base to 25.5 millimeters at its aperture. The corresponding lateral diameters are estimated at 18 and 20 millimeters. The ventral side of the margin of its aperture is only faintly more narrowly convex than its dorsal part.

Occurrence: Wilmington, Ohio, from the Moodie quarry; in the Cedarville dolomite. Wilmington College, in the collection of Dr. L. D. Welch; fig. 4A.

U. S. National Museum, no. 82171 C; fig. 4 B.

5. *Cyrtorizoceras lucillum* (Hall)*Plate 29, figures 2 A, B, C, D*

1868. *Cyrtoceras lucillum* Hall. 20th Rep. New York State Mus. Nat. Hist., p. 349, pl. 18, fig. 7, and the cross section in the interior of fig. 6.

The figure published by Hall was based on two fragments, probably not belonging to the same individual. At least, the annulations crossing the upper fragment are more directly transverse, while those of the lower fragment curve more distinctly downward in a ventrad direction; moreover, along the median part of their ventral side these annulations curve downward in an angulate manner in the upper fragment, while those of the lower fragment indicate a more evenly rounded hyponomic sinus at early stages of development. Between these two fragments there is a missing part, supplied by the artist in his reconstruction of the figure. Along the convex ventral outline of the lower fragment its radius of curvature is 30 millimeters while that of the upper fragment evidently is much less, but the rate of uncoiling is known to increase with age. Where the dorsoventral diameter of the upper fragment is 21 millimeters, its lateral diameter is 17 millimeters. A similar ratio is observed at the top of the lower fragment. The annulations are distinct dorsally as well as laterally and ventrally. Neither fragment retains any trace of the septa or siphuncle.

Occurrence: Wauwatosa, Wisconsin; from the Racine dolomite. American Museum of Natural History, no. 2120

6. *Cyrtorizoceras williamsi* new species*Plate 40, figure 5*

1919. *Maelonoceras arcticameratum* M. Y. Williams. The Silurian Geology and Faunas of Ontario peninsula, and Manitoulin and adjacent islands. Geol. Surv. Canada, Memoir 111, p. 79, pl. 27, fig. 2.

The holotype is about 110 millimeters long in direct measurement. The radius of curvature of its convex ventral outline is 70 millimeters along almost its entire length, but with a slight

change in direction about 55 millimeters above the base of the phragmacone. Its dorsoventral diameter increases from 7.5 millimeters at the base of the specimen to 30 millimeters at the base of the living chamber which is 75 millimeters farther up in direct measurement. The lateral diameter can not be determined with accuracy but is estimated at 17 millimeters where the dorsoventral diameter is 20 millimeters, and at 24 millimeters where the latter is 30 millimeters. Of the living chamber a length of 35 millimeters is preserved. The number of camerae in a length equal to the dorsoventral diameter equals 8 at the top of the phragmacone. The uppermost camera is distinctly shorter than those immediately beneath. The sutures of the septa curve downward about 3 millimeters laterally at the top of the phragmacone and rise slightly higher ventrally than dorsally. The siphuncle is almost in contact with the ventral wall of the conch, and is slightly less than 2 millimeters in diameter where the dorsoventral diameter of the conch is 20 millimeters. The segments of the siphuncle are subfusiform in outline, expanding slightly within the camerae.

Occurrence: Cape Hurd, at the northern end of Bruce peninsula, west of Georgian Bay, Ontario; in the Guelph dolomite.

National Museum of Canada, no. 5136.

Remarks.—Compared with *Cyrtorizoceras fosteri* (Hall) the conch of this species is less curved lengthwise, enlarges at a slower rate, and the sutures of its septa rise less strongly on approaching the ventral side of the conch.

#### 6a. CYCLORIZOCERAS Foerste

Genotype: *Cyrtoceras brevicorne* Hall. 20th Rep. New York State Cab. Nat. Hist., p. 356, pl. 18, figs. 8, 9 (1868). Also Foerste, Aug. F., Port Byron and other Silurian cephalopods, Jour. Sci. Lab. Denison Univ., vol. 25, p. 39, pl. 25, fig. 8 (1930).

Conchs cyrtconic, enlarging evenly as far as the aperture, cross section circular, siphuncle almost in contact with the ventral wall of the conch, its segments fusiform.

Under the name *Cyrtoceras* cf. *brevicorne* Clarke and Ruede-

mann (9) figured two specimens, from the Guelph dolomite of New York. That from the Guelph at Rochester (pl. 13, fig. 11) has about the same rate of enlargement as the genotype, but the camerae are much taller, at least much taller than the single camera preserved at the top of the phragmacone of the latter. That from the Lower Guelph horizon at Shelby, about 2 miles south of Medina, New York (pl. 13, fig. 12), enlarges at a much smaller rate, and evidently belongs to a different species. Neither one is a typical form of *Cyclorizoceras brevicorne* (Hall), described originally from the Racine dolomite of Racine, Wisconsin. On the other hand, the specimen figured by Clarke and Ruedemann from the Lower Guelph at Shelby, New York (pl. 15, figs. 4, 5), under the name *Cyrtoceras orodes* differs but slightly from this genotype. Two of the specimens here discussed are in the New York State Museum, the second one of those identified as *Cyrtoceras* cf. *brevicorne* being numbered 5115, and the one identified as *Cyrtoceras orodes* being numbered 5116.

#### EKWANOCERAS Foerste and Savage

Genotype: *Ekwanoceras breviconicum* Foerste and Savage. Ordovician and Silurian cephalopods of the Hudson Bay area, Jour. Sci. Lab. Denison Univ., vol. 22, p. 51, pl. 23, figs. 2; 1 A, B (1927).

Conch strongly curved lengthwise, enlarging rapidly, even along the living chamber, circular or almost circular in cross section. The hyponomic sinus is very shallow and is located on the convexly curved side of the conch. The siphuncle is central in location and the form of its segments appears to be either cylindroid or barrel-shaped, strongly contracting at the septal necks.

The reference of the Wilmington species here described as *Ekwanoceras* (?) *austini* to this genus is merely tentative, in view of the fact that the location and structure of its siphuncle is unknown. Moreover, the recurvature of the dorsal outline of its living chamber from concave below to convex above is unknown in the genotype, so that there is no reason for believing that the two species are congeneric, though somewhat similar in form.

7. *Ekwanoceras* (?) *austini* new species*Plate 36, figures 1 A, B*

The holotype consists of a cast of the interior of a living chamber. Its ventral outline is 38 millimeters along and has a radius of convex curvature of 60 millimeters. Its dorsal outline is 30 millimeters long, the lower half of this outline being slightly concave, changing to slightly convex along its upper half. The radius of curvature of its lateral outline changes from 100 millimeters along its lower two thirds to 60 millimeters farther up. The dorsoventral diameter of the conch increases from 37 millimeters at its base to 57 millimeters at its top, the corresponding lateral diameters being 37 and 56 millimeters, indicating a circular cross section. The conch evidently increased rapidly in size both dorsoventrally and laterally until within a short distance of the aperture where the rate of its enlargement laterally decreases conspicuously. The dorsal outline of the missing phragmacone must have been distinctly concave. A narrow groove is located 4 millimeters beneath the margin of the aperture. This groove is 2 millimeters wide and slightly over half a millimeter deep. Since the specimen is a cast of the interior of the living chamber the groove evidently represents an annular thickening on the interior of the shell, as in the living chamber of many other cyrtoceroids. On the median part of the ventral side of this chamber the groove in question curves downward, suggesting the presence of a broad and shallow hyponomic sinus at the margin of the aperture, about 30 millimeters wide and 5 millimeters deep. The siphuncle is assumed to have been located near the ventral wall of the conch.

Occurrence: Wilmington, Ohio, in the Moodie quarry.

Wilmington College, in the collection of Dr. L. D. Welch.

Remarks.—The reference of this living chamber to *Ekwanoceras* is only tentative, in the absence of any knowledge of the location of its siphuncle. In typical *Ekwanoceras* the location of the siphuncle is central. In the Wilmington species here described it may be ventral. However, the Wilmington specimen resembles the Hudson Bay genotype *Ekwanoceras breviconicum*

Foerste and Savage in the rounded cross section and general form of its living chamber.

### WORTHENOCERAS Foerste

Genotype: *Worthenoceras elongatum* Foerste. Port Byron and other Silurian cephalopods; Jour. Sci. Lab., Denison Univ., vol. 25, p. 76, pl. 13, figs. 6 A, B; 7 A, B; 8 A, B (1930).

Conch somewhat similar to *Amphicyrtoceras* in form, but more slender and much less curved, its dorsal outline being almost straight along the living chamber and the upper half of the phragmacone. The lateral enlargement of the conch also is small and in the more typical species this enlargement continues upward for about one third of the length of the living chamber, but in other specimens its largest diameter is located at the base of this chamber.

The two specimens here described under *Worthenoceras* are similar to the species already described in their slender form, and the straightness of their dorsal outline along the living chamber and a considerable part of the phragmacone. This is true especially of *Worthenoceras subfusiforme*, while in *Worthenoceras racinense* the lower part of the dorsal outline of the phragmacone is slightly concave. The hyponomic sinus of *Worthenoceras subfusiforme* has not been observed in any other species of this genus.

#### 8. *Worthenoceras* (?) *racinense* new species

*Plate 35, figure 2; plate 38, figures 2 A, B*

The holotype is about 100 millimeters long; it is moderately curved lengthwise and slightly depressed dorsoventrally. Along its convex ventral outline the radius of curvature is 110 millimeters as far as the point of maximum cross section of the conch, changing here to a radius of 75 millimeters, the curvature diminishing again toward the aperture. Along its concave dorsal side the radius of curvature equals 125 millimeters along its lower third, this outline becoming practically straight for a length of 50 millimeters opposite the more convex part of the

ventral outline of the conch, and then for a length of 10 millimeters this outline becomes slightly concave again as far as the aperture. The dorsoventral diameter of the conch increases from 20 millimeters at its base to 38 millimeters at its maximum, diminishing to 27 millimeters at the aperture. The corresponding lateral diameters are 22, 41, and 31 millimeters. The shell is scarcely one third of a millimeter thick. Its surface is crossed by low and rather broad striae which are almost directly transverse on the ventral side of the conch, their downward curvature along the median part of the latter being almost imperceptible.

Occurrence: Racine, Wisconsin; from the Racine dolomite. Illinois State Museum, no. 8382 D.

Remarks.—The holotype of this species is characterized by its slender proportions, though less slender than in *Worthenoceras subfusiforme*, and more distinctly curved at its base.

#### 9. *Worthenoceras* (?) *subfusiforme* new species

Plate 30, figures 4 A, B, C; plate 37, figure 2

The holotype enlarges slowly, is only slightly curved lengthwise, and is dorsoventrally depressed, especially along its dorsal side. The living chamber contracts moderately toward the aperture. The margin of this aperture rises in a ventrad direction and curves downward along the median part of its ventral side so as to form a distinct hyponomic sinus. The length of the specimen along its ventral outline is 77 millimeters. Its radius of curvature along this convex outline is about 140 millimeters for a length of 55 millimeters along the phragmacone, changing to about 70 millimeters along the living chamber. The concavity of the dorsal outline equals about 1 millimeter, its maximum being at the base of the living chamber. The dorsoventral diameter of the conch increases from 19 millimeters at its base to 23.5 millimeters between 33 and 53 millimeters farther up, and then diminishes gradually to 19 millimeters at the aperture. The corresponding lateral diameters are 21.5, 28, and 24 millimeters. The margin of the aperture rises in a ventrad direction at an angle of 30 degrees with the horizontal. Along the median

part of its ventral side it curves downward along a width of 8 or 9 millimeters and to a depth of 1.4 millimeters. The interior of the conch is not preserved, but the siphuncle evidently was located on the ventral side of the conch. The surface of the shell is striated transversely, about 10 to 12 striae in a length of 10 millimeters. These rise at an angle of 3 or 4 degrees with the horizontal along the lower part of the specimen, this angle increasing toward the aperture. Faint traces of vertical lines also occur.

Occurrence: Wilmington, Ohio; from the Moodie quarry; in the Cedarville dolomite.

U. S. National Museum, no. 89818.

There also are two fragments of the lower part of the conch which show the rate of enlargement here, one of these fragments being represented by figure 2 on plate 37.

Remarks.—In its lateral aspect this species resembles that of *Worthenoceras crooki* Foerste from the Port Byron dolomite at Port Byron, Illinois. However, nothing definite is known of the location or structure of its siphuncle, though the distinctness of the hyponomic sinus suggests that this siphuncle was located close to the ventral wall of the conch. Moreover, it is not known that a hyponomic sinus is distinctly developed in typical *Worthenoceras*.

#### GRIMSBYOCERAS new genus

Genotype: *Cyrtoceras clitus* Billings. Cat. Sil. Foss. Anticosti, Geol. Surv. Canada, p. 85, text fig. 24.

Conchs cyrtoconic, fusiform, the living chamber contracting toward the aperture. Siphuncle small, located close to the convex ventral wall of the conch but not in contact with the latter; its segments fusiform.

The holotype, *Grimsbyoceras clitus*, and the two species *Grimsbyoceras teucer* and *Grimsbyoceras corydon*, are all from the same locality and horizon. Whether the two Ohio species here described as *Grimsbyoceras genuiflexum* and *Grimsbyoceras hillsboroense* are strictly congeneric can not be determined in our present knowledge of their internal structure, however, their horizon is approximately the same.

10. *Grimsbyoceras clitus* (Billings)*Plate 40, figures 2 A, B*

1866. *Cyrtoceras clitus* Billings. Cat. Sil. Foss. Anticosti, Geol. Surv. Canada, p. 85, text fig. 24.

The holotype is 44 millimeters long in a direct line. It is fusiform, curved lengthwise, and slightly depressed dorsoventrally. Its convex ventral outline has a radius of curvature of 40 millimeters along the lower 30 millimeters of its length, and then curves backward at an angle of about 140 degrees as far as the aperture. The radius of curvature of its concave dorsal outline changes from 30 millimeters along its lower half to 40 millimeters farther up. Its dorsoventral diameter enlarges from 4.5 millimeters at its base to 17.3 millimeters at a point 33 millimeters farther up and then contracts to 16 millimeters at the aperture after an additional interval of 14 millimeters. The corresponding lateral diameters are 4.5, 17.3, and 15.5 millimeters. There is no gibbosity of its dorsal outline at the maximum diameter of the conch as illustrated in Billings's figure, cited above. At the apical end of the specimen 3 camerae occupy a length of 4 millimeters. The siphuncle is almost in contact with the ventral wall of the conch. Its diameter is 0.75 millimeter, and the form of its segments is narrowly fusiform, narrowing toward the septa. The surface of the shell is striated in a direction almost directly transverse to the curved vertical axis of the conch, but along the median part of their ventral course they curve slightly but distinctly downward along a width of 3 or 4 millimeters.

Occurrence: Grimsby, Ontario; in the upper part of the Lockport formation.

National Museum of Canada, no. 2739.

Remarks.—The figure of *Cyrtoceras clitus* accompanying the original description cited above differs from the specimen preserved in the National Museum of Canada as its type in lacking the angulation at the base of the living chamber along its ventral outline, and in showing a distinct gibbosity along the corresponding part of its dorsal outline, where the specimen in the National Museum of Canada fails to show it.

11. *Grimsbyoceras teucer* (Billings)

Plate 40, figures 3 A, B

1866. *Oncoceras teucer* Billings. Catalogues Sil. Foss. Anticosti, Geol. Surv. Canada, p. 86, text fig. 26.

The holotype is 39 millimeters long in a direct line. It is fusiform, curved lengthwise, and slightly depressed dorsoventrally. The lower part of its convex ventral outline, for a length of 25 millimeters, has a radius of curvature of 40 millimeters, bending back above this point at an angle of 140 degrees for a length of 14 millimeters as far as the aperture. The radius of curvature of the concave dorsal outline changes from 40 millimeters along most of its length to 30 millimeters at its top. The dorsoventral diameter increases from 8.5 millimeters at its base to 16 millimeters in a length of 25 millimeters, and then decreases to 14 millimeters at the aperture. The corresponding lateral diameters are 9, 17, and 15 millimeters. The relative distance between the septa is not known. Where the dorsoventral diameter of the conch is 8 millimeters the diameter of the siphuncle is 0.7 millimeter and its distance from the ventral wall of the conch also is 0.7 millimeter. It is assumed from the general resemblance of this species to *Grimsbyoceras clitus* Billings that the form of the segments of its siphuncle is narrowly fusiform. The surface of the shell is crossed by striae which are almost directly transverse to its curving central axis. Along the median part of the ventral side, for a width of 7 to 10 millimeters, they curve gently downward, indicating a very shallow hyponomic sinus. At the aperture, along this hyponomic sinus, the ventral outline of the conch curves gently outward for a distance of about half a millimeter beyond the general outline of the shell.

Occurrence: Grimsby, Ontario, about 15 miles east of Hamilton; from the upper part of the Lockport limestone.

National Museum of Canada, no. 2745.

Remarks.—This species differs from *Grimsbyoceras clitus* (Billings) chiefly in the more abrupt contraction of the conch above its maximum gibbosity, and in the slight outward curvature of the margin of its aperture at the hyponomic sinus.

12. *Grimsbyoceras corydon* (Billings)

Plate 39, figures 3 A, B, C

1866. *Cyrtoceras corydon* Billings. Cat. Sil. Foss. Anticosti, Geol. Surv. Canada, p. 85, text fig. 23.

Conch 50 millimeters long in a direct line, but 60 millimeters long when measured along its convex ventral outline; fusiform in shape, but strongly curved lengthwise, especially at the top of the phragmacone and the base of the living chamber, resulting in a geniculate dorsoventral outline. The radius of curvature of its convex ventral outline varies from 40 millimeters along the lower 24 millimeters of its length to 20 millimeters along its geniculate portion, the upper 15 millimeters of this outline showing a tendency toward straightening. The radius of curvature of its concave dorsal outline decreases from 40 millimeters along the lower 18 millimeters of its length to 15 millimeters for a length of 10 millimeters, opposite the more geniculate part of the conch, and then changes to faintly convex almost as far as the aperture, its maximum convexity here being located 8 or 9 millimeters beneath the aperture. Its dorsoventral diameter enlarges from 6 millimeters at its base to 20 millimeters at the base of the living chamber and then decreases to 15 millimeters just beneath the aperture. The corresponding lateral diameters are 6, 22, and 19 millimeters, the cross section of the conch changing from circular at its base to dorsoventrally depressed at the top of the phragmacone, this depression increasing toward the aperture. At the aperture the diameter of the conch enlarges slightly along a length of a little more than one millimeter. The length of the living chamber along its ventral outline is 20 millimeters. The septum at its base is only moderately concave. Traces of septa are seen at different intervals but not with sufficient sharpness or number to indicate the relative number of camerae within a given length of the phragmacone. The siphuncle is near the ventral wall of the conch but not in contact with the latter. At the top of the phragmacone its diameter is 1.3 millimeters. Its form apparently is fusiform. Along the lower part of the conch the striae on the surface of the shell are

almost directly transverse to the curving central axis of the conch. Toward the more gibbous part of the conch these transverse striae slope moderately downward in a ventrad direction. This downward slant is greatest at the maximum geniculation, but continues as far as the aperture, though at a decreasing angle. Along the median part of their ventral course there is a slight tendency toward angulation in the downward curvature of these striae, thus suggesting a faint trace of a hyponomic sinus.

Occurrence: Grimsby, Ontario; in the upper part of the Lockport formation.

National Museum of Canada, no. 2740.

Remarks.—*Grimsbbyoceras corydon* appears closely related to *Grimsbbyoceras clitus* and *Grimsbbyoceras teucer* from the same locality and horizon, differing from the latter chiefly in its geniculate form.

### 13. *Grimsbbyoceras genuiflexum* new species

Plate 32, figures 1 A, B, C; 2 A, B, C

The holotype consists of a living chamber and of a considerable part of the phragmacone, but only the exterior of the shell is exposed where the two come in contact, so that the exact length of the living chamber can not be determined. The length of this specimen along its convex ventral outline is estimated at 66 millimeters, the margin of the aperture not being preserved. Dorsally the corresponding length is 40 millimeters. Ventrally its radius of curvature is 50 millimeters for a length of 33 millimeters along the lower part of the conch, changing to 25 millimeters for a length of 20 millimeters along its most geniculate part, and then to about 70 or 80 millimeters along the upper part of its outline. Dorsally the radius of curvature of its concave outline is 20 millimeters for a length of 14 millimeters above the base of the specimen, the top of this length reaching the most strongly concave part of this outline, where the radius of curvature is 15 millimeters. Farther up, this radius changes first to 25 millimeters, and then to 40 or 50 millimeters as far as the aperture. The dorsoventral diameter of the conch en-

larges from 13.5 millimeters at its base to 28 millimeters at a point 44 millimeters farther up and then decreases to about 21 millimeters at the aperture. The corresponding lateral diameters are 14 millimeters, 31.7 millimeters, and 26.5 millimeters, with the maximum lateral diameter about 5 millimeters farther up than the maximum dorsoventral one. The conch evidently is nearly circular at earlier stages of growth but becomes distinctly depressed dorsoventrally at later stages, contracting toward the aperture. The only septum exposed is that at the base of the specimen. The suture of this septum apparently is straight and directly transverse to the curved vertical axis of the conch. Its concavity is slight. The siphuncle can not be detected here but it is assumed to have been located near the ventral wall of the conch. The surface of the shell is crossed at irregular intervals by lines of growth which slope downward in a ventrad direction at an increasing rate, indicating a broad but relatively shallow hyponomic sinus. The margin of the aperture of the living chamber is not preserved, but it is assumed to have been similar in direction to the uppermost striae actually preserved.

Occurrence: Hillsboro, Ohio, in the Trimble quarry at the end of the abandoned railroad extension in the northeastern margin of the city; in the lower part of the Peebles dolomite.

Ohio State University, no. 5903.

A second specimen, provisionally referred to the same species, is about 67 millimeters in length along its convex ventral outline. The radius of curvature of this outline is more uniform, equalling 30 millimeters throughout its length. Its maximum diameter in a dorsoventral direction is 30 millimeters, its maximum lateral one, located a little farther up, being 33 millimeters. The transverse lines of growth occur at irregular intervals, and their downward slope in a ventrad direction begins nearer the dorsal side of the conch. The phragmacone apparently enlarged at a less rapid rate. The most interesting feature in this specimen, however, is the cast of some structure formed by the matrix within the upper part of the living chamber. This cast apparently gives some idea of the general form of the animal at this point, probably when this animal extended as far as it could outside of the

living chamber. The outline of this animal apparently was lobate along the right side of its dorsal surface.

Occurrence: Highland county, Ohio; presumably from the Trimble quarry on the northeastern edge of Hillsboro, Ohio; from the lower part of the Peebles dolomite.

Ohio State University, no. 9888.

#### 14. *Grimsbyoceras hillsboroense* new species

*Plate 31, figures 2 A, B, 3; pl. 36, figs. 4 A, B*

The holotype is 72 millimeters long in a direct line but measured along its convex ventral outline its length is 90 millimeters, and apparently 20 millimeters of this length belongs to the living chamber. The radius of curvature of its ventral outline changes from 60 millimeters along the lower 43 millimeters of its length to 30 millimeters along the following 27 millimeters, and then increases to 50 millimeters along the living chamber. The dorso-ventral diameter of the conch enlarges from 22 millimeters at its base to 34.5 millimeters at its most prominent geniculation, and then decreases to 27 millimeters at the aperture. The lateral diameter enlarges from approximately 20 millimeters at the base of the conch to 35 millimeters at the base of the living chamber and to 36 millimeters at a point 8 millimeters farther up laterally, and then contracts to 30 millimeters at the aperture. These measurements indicate that the cross section of the conch was slightly compressed laterally at its base, became circular at its greatest geniculation, and was distinctly depressed dorsoventrally at the aperture. The suture of the septum at the base of the specimen is almost directly transverse to its curving vertical axis and it curves downward laterally slightly over 1 millimeter, the concavity of this septum equalling 2 millimeters. No trace of the siphuncle can be detected. Also, no trace of any additional sutures of septa can be found until a point 24 millimeters beneath the ventral margin of the base of the living chamber and 8 millimeters below its dorsal margin is reached. Within this interval there are 5 sutures indicating camerae whose lengths on the ventral side of the conch, in ascending order, are 8, 7, 6, and

3 millimeters, the conch evidently having reached its gerontic stage of growth. These upper sutures are almost straight, curving only faintly downward laterally, but they rise distinctly in a ventrad direction, as indicated in fig. 2 B on pl. 31. Along the greater part of the length of the conch only the surface of its shell is preserved. This retains traces of transverse striae which tend to become more prominent at intervals of 6 or 7 millimeters along the ventral side of the conch. These striae curve increasingly downward in a ventrad direction, their slant being slight dorso-laterally, but much more conspicuous ventrolaterally, indicating the presence of a broad and shallow hyponomic sinus almost equalling the entire conch in width but curving downward only 3 to 5 millimeters below their level laterally.

Occurrence: Hillsboro, Ohio; in the Trimble quarry at the end of the railroad branch in the northeastern margin of the city; from the lower part of the Peebles dolomite.

U. S. National Museum, no. 81931 A.

A specimen, apparently similar in the course of the sutures of its septa, is of interest chiefly on account of the peculiar form assumed by the matrix filling its interior and extending upward beyond its top. Possibly this has some connection with the form of the lower part of that portion of the animal extending out of the living chamber when fully exerted. From the same locality and horizon as the holotype. No. 81931 B.

Remarks.—The reference of this species to *Grimsbyoceras* in the absence of any knowledge of its siphuncle, is only tentative. As far as known, the geniculate curvature of the conch, shown by this and other species, is not a generic character, but may occur in various cyrtoconic genera.

#### 15. *Grimsbyoceras* (?) *orodes* (Billings)

Plate 40, figures 4 A, B

1865. *Cyrtoceras orodes* Billings. Palaeozoic Fossils, Geol. Surv. Canada, vol. 1, p. 162.

1895. *Cyrtoceras orodes* Whiteaves. Palaeozoic Fossils, Geol. Surv. Canada, vol. 3, pt. 2, p. 103, pl. 14, figs. 7, 7a (not figs. 8, 8a, 8b, 9).

The holotype consists of a single individual broken into four fragments which can be fitted together. Its length in a direct line is about 60 millimeters. The radius of curvature of its convex ventral outline is 52 millimeters. The lateral diameter of the conch enlarges from about 15 millimeters at the base of the tenth camera beneath the living chamber to 24 millimeters at the base of this chamber, which is 39 millimeters farther up when measured along its ventral outline. Measurements directly transverse to the curving vertical axis of the conch are practically circular, but parallel to the sutures of the septa, which rise in a ventrad direction, the dorsoventral diameters necessarily are slightly longer, equalling nearly 26 millimeters at the base of the living chamber. The specimen consists of the living chamber and of the 11 camerae still attached. On the right lateral side of the specimen the living chamber is preserved for a height of 16 millimeters. This chamber enlarges at the same rate as the phragmacone as far as the upper margin of the part preserved. The margin of its aperture may have curved slightly downward ventrally, but this is not certain. At the top of the phragmacone 6 camerae occur in a length equal to the lateral diameter of the conch at the base of the living chamber. The sutures of the septa curve downward laterally, and at the top of the phragmacone they rise distinctly higher ventrally than dorsally. Several of the upper ventral saddles show a faint tendency toward angulation along their median part. The concavity of the uppermost septum is estimated at 4 millimeters; that of the sixth septum farther down is slightly over 2 millimeters. In the second camera beneath the living chamber the siphuncle is scarcely 2 millimeters in diameter, and its distance from the ventral wall of the conch is scarcely half a millimeter. In the sixth camera beneath the latter the diameter of the siphuncle is about 1.5 millimeters. These segments of the siphuncle are fusiform, their constriction toward the septa being moderate. A small part of the surface of the shell is preserved on the dorsal side of the living chamber. This is crossed by 6 or 7 faint transverse striae in a length of 2 millimeters. There are also several lines of growth which are stronger than the striae and more distant from each other. In

addition there are numerous vertical lines, too faint to be seen readily without a lens.

Occurrence: Hespeler, formerly called New Hope, about 4 miles north of Galt, in Waterloo county, Ontario, Canada; in the Guelph dolomite.

National Museum of Canada, no. 2921.

Remarks.—The affinities of this species remain in doubt, chiefly on account of inadequate knowledge of the structure of its siphuncle. If the segments of this siphuncle are fusiform, as stated above, then this species can not be an *Amphicyrtoceras*. Moreover, its strong lengthwise curvature, its circular cross section, and the strong downward curvature of the sutures of its septa are opposed to such a relationship. On the other hand, the strong downward curvature of these sutures also is opposed to its relationship with typical *Grimsbyoceras*, so that its reference to that genus can be only tentative.

The two specimens from Durham, Ontario, figured by Whiteaves in the publication cited above under the name *Cyrtoceras orodes* (pl. 14, figs. 8, 8a, 8b, 9), on the other hand, almost certainly belong to *Amphicyrtoceras*. This is shown by their conspicuous dorsoventral depression, the location of the siphuncle near but not in contact with the ventral wall of the conch, the barrel-shaped form of its segments, and the slight downward curvature of the transverse striae along the median part of the ventral side of the surface of the shell.

In the same manner, in figures 10 and 11 on plate 15 of the Guelph Fauna in the state of New York [Memoir 5, New York State Museum, 1903], by Clarke and Ruedemann, the dorsoventral outline of the upper part of the conch is that of a typical *Amphicyrtoceras*. New York State Museum, no. 5117.

Figures 6 to 9 on the same plate evidently do not belong to the same species. The camerae are relatively shorter ventrally, the sutures of the septa rise in a ventrad direction, and the siphuncle is located in contact with the ventral wall of the conch. Moreover the segments of this siphuncle appear to be more nearly fusiform than barrel-shaped, simulating in this respect such

conchs as those described under *Euryrizoceras percurvatum* Foerste from Port Byron, Illinois, and Wilmington, Ohio. However, the generic reference of the latter species also is in doubt, the genotype of *Euryrizoceras* being *Euryrizoceras chadwicki* Foerste, also from Port Byron.

15a. **GONATOCYRTOCERAS** Foerste

Genotype: *Cyrtoceras heteroclytium* Barrande. Systeme silurien du centre de la Boheme, vol. 2, pt. 1, p. 550, 1867; pl. 118, figs. 15-18 (1866).

In the genotype of *Gonatocyrtoceras* the cross section of the conch is strongly depressed dorsoventrally, this depression being most conspicuous at the top of the phragmacone and base of the living chamber, where the dorsal part of the cross section is more distinctly flattened than its ventral part. The contraction of the living chamber toward its aperture is conspicuous. The siphuncle is located near the ventral wall of the conch but apparently was not in contact with the latter. The small size of the passage of this siphuncle through the septum at the top of the phragmacone suggests that the siphuncle itself was of small diameter.

From the Devonian of Konieprus, in Bohemia.

**AUSTINOCERAS** new genus

Genotype: *Austinoceras turgidulum* Foerste.

Conchs relatively small, cyrtconic, moderately curved along the concave dorsal outline but conspicuously and almost angularly curved along the convex ventral outline. Conch enlarging rapidly both laterally and dorsoventrally as far as the geniculation and then contracting strongly but evenly as far as the aperture. Siphuncle of medium size and located near the ventral wall of the conch but not in contact with the latter. Cross section approximately circular, neither strongly compressed nor depressed.

The genotype, from Wilmington, Ohio, is strongly similar to the species formerly described under *Gonatocyrtoceras inflatum*. Foerste from the Joliet member of the Niagaran at Joliet, Illinois.

16. *Austinoceras turgidulum* new species*Plate 33, figures 4 A, B*

The holotype is 52 millimeters long in direct line, its curved ventral outline being nearly 60 millimeters in length. This outline is geniculate, its maximum geniculation being located 30 millimeters above the base of the specimen, at a distance of two camerae beneath the base of the living chamber. Beneath this point the radius of curvature of the ventral outline is 40 millimeters; above this point it is 50 millimeters, the angle at this geniculation equalling 140 degrees. The concavity of the dorsal outline has a radius of curvature of 100 millimeters. The dorso-ventral diameter of the conch increases from 17 millimeters at its base to 27.5 millimeters at the geniculation and then decreases to 21 millimeters at the aperture. The corresponding lateral diameters are 16, 27, and 18 millimeters. Below the geniculation there are 5 camerae occupying a total length of 29.5 millimeters along their ventral outline. Of these, the camera just beneath the geniculation is 8 millimeters long, the two immediately above measuring 7 and 4.5 millimeters in ascending order, the conch having reached its gerontic stage of growth. At the base of the specimen the suture of the septum is almost directly transverse to the curving vertical axis of the conch. Above this level the sutures of the septa rise at an increasing angle in a ventrad direction. The living chamber is at least 15 millimeters long, possibly 20 millimeters, and the margin of its aperture appears to have been subparallel to the suture of the uppermost septum. The septum at the base of the specimen has a concavity of 2 millimeters. The diameter of the siphuncle here is 3.2 millimeters within the camera, narrowing to 1.5 millimeters at the septal neck. Its distance from the ventral wall of the conch is 0.6 millimeter. No trace of markings on the surface of the shell remains.

Occurrence: Wilmington, Ohio, from the Moodie quarry; in the Cedarville dolomite.

U. S. National Museum, no. 89819.

Remarks.—This Wilmington specimen resembles closely the

holotype of the species described as *Gonatocyrtoceras inflatum* Foerste (10) from the Joliet member of the Niagaran at Joliet, Illinois, and with which it is congeneric. However, the Wilmington specimen is less strongly curved, both dorsally and ventrally, and the rate of enlargement of the lower part of the phragmacone is less. The absence of any trace of sutures of septa at and above the geniculation of the Joliet specimen probably is due to imperfect preservation.

### BYRONOCERAS Foerste and Savage

Genotype: *Byronoceras longidomum* Foerste and Savage. Ordovician and Silurian cephalopods of the Hudson Bay area; Jour. Sci. Lab. Denison Univ., vol. 22, p. 82, pl. 24, figs. 3 A, B (1927). See also Foerste, Port Byron and other Silurian cephalopods, Jour. Sci. Lab., Denison Univ., vol. 25, p. 87, pl. 16, figs. 3 A, B (1930).

Conch moderately curved lengthwise, with its ventral outline convex; enlarging slowly. Almost circular in outline, slightly depressed, with the siphuncle almost in contact with the ventral wall of the conch. Sutures of septa straight and almost directly transverse to the curving vertical axis of the conch. Segments of the siphuncle obliquely oval or nearly globular, their obliquity being due to their location near the wall of the conch where the septa rise strongly.

The species here described as *Byronoceras* (?) *radiciforme* appears similar in structure generically.

#### 17. *Byronoceras* (?) *radiciforme* new species

Plate 34, figures 3 A, B

The holotype includes the living chamber and the upper three camerae. Its lengthwise curvature is moderate, and its cross section is nearly circular. Along its convex ventral outline its radius of curvature is 25 millimeters. Along its concave dorsal outline the corresponding radius is 40 millimeters, except near the aperture where this dorsal outline curves more strongly outward. Along its ventral outline the living chamber is 14 millimeters in

length, its aperture apparently sloping slightly downward in a dorsad direction. At the base of the living chamber its dorso-ventral diameter is 11 millimeters and its lateral diameter is 11.5 millimeters. At midheight of this chamber its dorsoventral diameter is 11.6 millimeters, its lateral one being 12.1 millimeters. The corresponding diameters at the aperture can not be determined with exactness. The uppermost camera is nearly 1.5 millimeters in length ventrally, the camera just beneath is nearly 2.5 millimeters long, and that next beneath apparently was of the same length, suggesting nearly 4 camera in a length equal to the diameter of the conch along the upper part of its phragmacone, the shortness of the uppermost camera suggesting that the conch had reached its gerontic stage of growth. The sutures of the septa are straight but rise slightly in a ventrad direction. The siphuncle is located near the ventral wall of the conch, at a distance of one to two tenths of a millimeter from the latter. The preservation of the siphuncle is poor, but it appears to have enlarged within the camerae to a diameter of about 1.3 millimeters. No trace of surface markings remains, and its surface probably was smooth.

Occurrence: Yellow Springs, Ohio; from the Cedarville dolomite in the upper part of the Middle Silurian.

Ohio State University, no. 14805.

Remarks.—In its subcircular cross section and general lengthwise curvature this species resembles *Byronoceras*. The enlargement of the segments of its siphuncle within the camerae also appears to be similar.

#### EURYRIZOCERAS Foerste

Genotype: *Euryrizoceras chadwicki* Foerste. Port Byron and other cephalopods; Jour. Sci. Lab. Denison Univ., vol. 25, p. 81, pl. 16, figs. 1 A, B; pl. 15, figs. 6 A, B (1930).

Cyrtocoines with concave dorsal and convex ventral outlines, enlarging laterally at an even rate as far up as midheight of the living chamber, and then contracting slightly toward the aperture. Moderately depressed dorsoventrally, chiefly owing to a slight flattening of the dorsal side, especially along the living

chamber. The sutures of the septa are nearly straight and are almost directly transverse to the curving central axis of the conch along the lower part of the phragmacone, but farther up they rise at an increasing angle in a ventrad direction. The siphuncle is close to the ventral wall of the conch but not in direct contact with the latter. Its segments are abruptly constricted at the septal necks as in *Amphicyrtoceras*, but present a less elongated appearance within the camerae.

In *Euryrizoceras anguloseptatum* the sutures of the septa rise slightly in a ventrad direction at the top of the phragmacone and tend to form low and subangular saddles there. In *Euryrizoceras percurvatum* Foerste the conch is strongly curved lengthwise and the sutures of the septa rise conspicuously in a ventrad direction, as in typical forms of this species described from the Port Byron dolomite at Port Byron in northwestern Illinois.

18. *Euryrizoceras anguloseptatum* new species

Plate 33, figures 3 A, B

Conch slightly depressed dorsoventrally, moderately curved lengthwise, the sutures of the septa rising slightly along the median part of their ventral sides, forming low angulate ventral saddles. In the holotype the ventral side is preserved for a length of 38 millimeters, 14 millimeters of this length belonging to the living chamber; originally this chamber evidently was longer. Along its ventral outline the radius of convex curvature is 80 millimeters. The dorsoventral diameter of the conch enlarges from about 15 millimeters at its base to 22 millimeters at the base of the living chamber, and is estimated to have equalled 25 millimeters at a point 14 millimeters farther up. The corresponding lateral diameters are approximately 18, 23.5, and 27 millimeters, suggesting slight dorsoventral depression. The camerae number 8 in a length equal to the lateral diameter of the conch. Since the uppermost camera is not shorter than those immediately beneath the conch evidently had not reached its gerontic stage of growth, and possibly may have grown to a distinctly larger size. The sutures of the septa rise slightly in a

ventrad direction along the upper part of the phragmacone and curve faintly upward along the median part of their ventral course. The septum at the base of the specimen has a concavity of 3 millimeters. The siphuncle is located here about 1 millimeter from the ventral wall of the conch. Its diameter at the septal necks is about 1.5 millimeters, enlarging to 2 millimeters at midheight within the camerae. There is no trace of markings on the surface of the shell, the latter not being preserved.

Occurrence: Wilmington, Ohio, in the Moodie quarry; in the Cedarville dolomite.

U. S. National Museum, no. 81925.

Remarks.—This species is characterized by the low subangular saddles of the sutures of the septa along the median part of the ventral side of the conch.

19. *Euryrizoceras* (?) *percurvatum* Foerste

Plate 33, figures. 5 A, B; 6

1930. *Euryrizoceras percurvatum* Foerste. Jour. Sci. Lab. Denison Univ., vol. 25, p. 84, pl. 16, figs. 1 A, B; pl. 15, figs. 6 A, B (1930).

The holotype consists of a living chamber to which 6 camerae still are attached. Of this chamber a length of 27 millimeters is preserved ventrolaterally. The six camerae occupy a total length of 44 millimeters along their ventral outline. The radius of curvature of this outline is 50 millimeters. The conch enlarges dorsoventrally from a diameter of 27 millimeters at its base to 38 millimeters at the level of the base of the living chamber ventrally and to 41 millimeters at a point 20 millimeters above this base. The lateral diameter at the base of the specimen is estimated at 32 millimeters and that at the base of the living chamber at 50 millimeters, the rate of enlargement above this level being small. The upper part of the living chamber flares moderately outward dorsolaterally, and a very shallow transverse groove occurs 23 millimeters above the ventral margin of the suture at the base of this chamber. The margin of the aperture probably was 5 millimeters above this groove. The

conch probably had reached full maturity. Slightly over 5 camerae occupy a length equal to the dorsoventral diameter of the conch when counted along their ventral outline. The sutures of the septa are almost straight, but they rise in a ventrad direction, this rise being small at the base of the specimen but becoming large at the top of the phragmacone. The siphuncle has a diameter of 3 millimeters at the base of the specimen where in contact with the septum beneath. Its full diameter can not be determined. Its distance from the ventral wall of the conch is about 1.5 millimeters.

A phragmacone associated with this holotype is about 102 millimeters long on its ventral outline, and includes 19 camerae. Its dorsoventral diameter enlarges from 14 millimeters at the top of the first camera to 34 millimeters at a point 76 millimeters farther up ventrally, this point being located at the base of the fourth camera from the top. The corresponding lateral diameters are estimated at 15 and 42 millimeters. The sutures of the septa rise rather strongly in a ventrad direction, even at early stages of growth, this rise increasing farther up. The siphuncle is close to the ventral wall of the conch, and is exposed along the latter by weathering in the lower nine camerae.

Occurrence: Wilmington, Ohio; from the Moodie quarry; in the Cedarville dolomite.

U. S. National Museum, no. 89820.

Remarks.—The Wilmington specimens apparently are identical specifically with those from the Port Byron dolomite at Port Byron, along the Mississippi river, in northwestern Illinois.

#### ANOMEIOCERAS Foerste

Genotype: *Anomeioceras compressum* Foerste. Jour. Sci. Lab. Denison Univ., vol. 25, p. 89, pl. 17, figs. 6 A, B (1930).

Conchs nearly circular in cross section, rather strongly curved lengthwise, more or less contracted toward the aperture. The sutures of the septa curve downward laterally and rise higher ventrally than dorsally. The siphuncle is located near the convex ventral side of the conch, and the segments of this siphuncle apparently are somewhat similar to those of *Amphicyrtoceras* in form.

Since only the living chamber of *Anomeioceras percurvatum* is known, the reference of this species to *Anomeioceras* can be only tentative.

20. *Anomeioceras percurvatum* new species

Plate 30, figures 2 A, B

The holotype consists of a living chamber strongly curved lengthwise. Only its left half is preserved, but this part suggests that the chamber was distinctly depressed dorsoventrally. Its convex ventral outline is 48 millimeters long and has a radius of curvature of 37 millimeters. Its concave dorsal outline is about 23 millimeters long and has a radius of curvature of 20 millimeters. The dorsoventral diameter of this chamber enlarges from 27.5 millimeters at its base to 33 millimeters at mid-height and then decreases to 30 millimeters at the aperture. The maximum lateral diameter near the aperture is estimated at approximately 41 millimeters. The ventral margin of the aperture curves slightly downward for a depth of 2 millimeters, suggesting a broad and very shallow hyponomic sinus. The septum at the base of the chamber has a concavity of 6 millimeters, its suture apparently curves distinctly downward laterally. No trace of the siphuncle is preserved but it is assumed to have been located near the convex ventral side of the conch. The surface of the shell apparently was minutely striated transversely.

Occurrence: Yellow Springs, Ohio; from the Cedarville dolomite.

Ohio State University, no. 3411.

Remarks.—In its lengthwise curvature this specimen resembles *Anomeioceras compressum* and *Anomeioceras vicinum* from the Port Byron dolomite of northwestern Illinois.

ECTOCYRTOCERAS Foerste

Genotype: *Ectocyrtoceras marginatum* Foerste. Port Byron and other Silurian cephalopods; Jour. Sci. Lab. Denison Univ., vol. 25, p. 79, pl. 9, figs. 2 A, B, C (1930).

Conch similar to that of *Amphicyrtoceras*, but its dorsal outline is concave along its entire length, including that at the top of the phragmacone and the base of the living chamber, while in *Amphicyrtoceras* this part of the outline is more or less gibbous. In the genotype the maximum diameter of the conch both dorso-ventrally and laterally, is a little below midheight of the living chamber, but not at the top of the phragmacone and the base of the living chamber as in typical *Amphicyrtoceras*. The median part of the ventral margin of the aperture curves slightly downward at the hyponomic sinus. The cross section of the conch is slightly depressed at the base of the living chamber, but this depression increases a little toward the aperture. The dorsal part of this cross section is slightly flatter than its ventral part. The siphuncle is located near the ventral wall of the conch but is not in contact with the latter.

Among the species here referred to this genus *Ectocyrtoceras billingsi* most closely resembles the genotype in the general form of its living chamber. *Ectocyrtoceras wilmingtontense* and *Ectocyrtoceras gibberosum* have a general resemblance to *Amphicyrtoceras* but the maximum diameter of the conch is distinctly above the base of the living chamber, being faint dorsally but conspicuous near midheight of this chamber ventrally. *Ectocyrtoceras thales* (Billings) differs from typical *Amphicyrtoceras* chiefly in its concave dorsal outline and in the slow rate of enlargement of the upper part of the phragmacone.

21. *Ectocyrtoceras* (?) *wilmingtontense* new species

Plate 33, figures 1 A, B; 2

The holotype is 64 millimeters long and includes the living chamber and the upper ten camerae. Of this length 25 millimeters belongs to the living chamber. The radius of curvature of its convex ventral outline changes from 50 millimeters along the lower five camerae to 120 millimeters along the following five camerae, and to 30 or 40 millimeters along the living chamber. The dorsoventral diameter increases from 19 millimeters at the base of the specimen to 33 millimeters at midheight of the living

chamber and then decreases to about 28 millimeters at the aperture. The corresponding lateral diameters are 22.5 millimeters, 41 millimeters, and 36 millimeters. The dorsal side of the cross section is distinctly flattened. Near the top of the living chamber the cast of the interior of the conch is contracted into a transverse groove whose maximum depth is about 3 millimeters below the margin of the aperture. This groove is distinct ventrally and laterally, its dorsal course being unknown. The sutures of the septa are straight and directly transverse to the curving vertical axis of the conch.

In a similar specimen of about the same size the siphuncle has been exposed along the lower 5 camerae by grinding away its ventral side. This siphuncle is about half a millimeter from the ventral wall of the conch. Its segments are subfusiform, enlarging but slightly within the camerae, attaining a diameter of about 2.2 millimeters. Where the lateral diameter of the conch is 31 millimeters the concavity of the septum is 4 millimeters.

Occurrence: Wilmington, Ohio, from the Moodie quarry; in the Cedarville dolomite.

U. S. National Museum, no. 89821.

Remarks.—The segments of the siphuncle of this species are relatively narrow. Those of typical *Ectocyrtoceras* are unknown.

## 22. *Ectocyrtoceras* (?) *gibberosum* new species

*Plate 32, figures 4 A, B*

The holotype consists of a living chamber to which parts of the upper 6 camerae still are attached. The conch is depressed dorso-ventrally, its dorsal side being somewhat flattened. Its lengthwise curvature appears to have been moderate except along the upper part of the living chamber where the convexity of its ventral outline is greatly increased. The length of the specimen in a straight line is 43 millimeters, of which 29 millimeters belongs to the living chamber. The radius of curvature of its convex ventral outline is 70 millimeters along the phragmacone and the lower half of the living chamber, decreasing to 20 millimeters farther up, the upper 5 millimeters of this chamber forming

a shallow groove around its entire circumference. Since this specimen is a cast of the interior of the conch, the groove along the upper margin of the living chamber probably corresponds to an annular thickening of the interior of the shell at this level, a feature often observed near the aperture of living chambers in cyrtoceroids. The dorsal outline of the specimen is slightly concave at the top of the phragmacone, becomes faintly convex along the greater part of the length of the living chamber, and then is faintly concave again near the aperture. The dorso-ventral diameter increases from 25 millimeters at the base of the living chamber to 29.5 millimeters at midheight of the latter, and then decreases to 25.5 millimeters at the aperture. The corresponding lateral diameters are estimated at 29, 32, and 31 millimeters. The lower 5 camerae have a total length of 16 millimeters ventrally, the sixth or uppermost one being distinctly shorter than the rest. The siphuncle is not preserved but is assumed to have been located near the ventral wall of the conch. No trace of surface markings on the shell remains.

Occurrence: Wilmington, Ohio, in the Moodie quarry; in the Cedarville dolomite.

U. S. National Museum, no. 89822.

Remarks.—This conch resembles *Ectocyrtoceras* in the absence of the gibbosity along its dorsal outline which characterizes typical *Amphicyrtoceras*. In other respects it resembles the latter genus.

### 23. *Ectocyrtoceras thales* (Billings)

Plate 39, figures 1 A, B

1866. *Oncoceras thales* Billings. Cat. Sil. Fossils of the island of Anticosti, Geol. Surv. Canada, p. 87.

Three specimens were described by Billings, but all appear to be lost. The first two of these were described as having a dorso-ventral diameter of 22 lines and a lateral one of 24 lines at the base of its living chamber, and the third was stated to be nearly circular in cross section and 25 lines across, but these dimensions do not agree with those of either one of the two specimens at hand. It is evident that the cross section of the conch in the

lost types was characterized by its small dorsoventral depression. Of the two specimens in the National Museum of Canada which are labelled *Oncoceras thales*, only one bears the printed label: *Oncoceras Thales* Billings; Grimsby, Niagara group; J. Pettit, indicating that it belonged to the type series studied by Billings, even if not individually described by him.

This specimen consists of a living chamber 36 millimeters long, to which 5 camerae 40 millimeters in length along their ventral outline still are attached. The radius of curvature of its ventral outline increases from 60 millimeters along the phragmacone to 100 millimeters along the living chamber. The concave outline of its dorsal side has a radius of curvature of 60 millimeters along the phragmacone and the lower half of the living chamber, reversing to slightly convex farther up. At the base of the living chamber its lateral diameter is estimated at 50 millimeters and its dorsoventral one is 42 millimeters. The conch continues to expand slightly for a length of 12 millimeters above this base, attaining here a maximum lateral diameter of 52 millimeters. Farther up its lateral diameter contracts to 46 millimeters at the top of the specimen which is 35 millimeters above the base of the living chamber, but this may be several millimeters below the margin of the aperture, the latter not being preserved. That part of the phragmacone preserved is 40 millimeters long. The lower 3 camerae occupy a length of 20 millimeters along the lateral sides of the conch, and their surface shows faint vertical ribbing, as in *Amphicyrtoceras laterale*. At the base of the specimen its lateral diameter is estimated at 39 millimeters and its dorsoventral one is 34 millimeters. The sutures of the septa slope slightly downward in a ventrad direction.

Occurrence: Grimsby, Ontario; in the upper part of the Lockport dolomite.

National Museum of Canada, no. 2746.

#### 24. *Ectocyrtoceras billingsi* new species

Plate 40, figures 1 A, B, C

The living chamber is estimated to have had a length of 47 millimeters when measured along its lateral side above the suture

of the septum at its base. The radius of curvature of its convex ventral outline is about 100 millimeters, that of its concave dorsal outline being about 130 millimeters. Its dorsoventral diameter increases from 38 millimeters at its base to 40 millimeters at a point 10 millimeters farther up and then decreases to about 36 millimeters at the aperture. Its lateral diameter is estimated at 43.5 millimeters at its base and approximately 38 millimeters at the aperture. The concavity of the septum at its base is about 10 millimeters. A short distance above the suture of this septum the cast of the interior of the living chamber presents an annular groove 2 millimeters in width vertically, divided into vertical pits, about 5 pits in a lateral width of 13 millimeters. The single segment of the siphuncle still attached to this living chamber is 7.3 millimeters wide, and its distance from the ventral wall of the conch is estimated at 1 millimeter.

Occurrence: Grimsby, Ontario; in the upper part of the Lockport dolomite.

National Museum of Canada, no. 2749.

Remarks.—This is one of the two specimens labelled *Oncoceras Thales* in the National Museum of Canada, but it does not bear a printed label, as in the specimen here selected as the type of *Ectocyrtoceras thales*. It evidently came from the same locality and horizon but is more nearly circular in cross section. In the latter respect it resembles the specimens described by Billings under *Oncoceras Thales*, though much smaller in diameter at the base of the living chamber.

#### AMPHICYRTOCERAS Foerste

Genotype: *Oncoceras orcas* Hall. 20th Rept. New York State Cab. Nat. Hist., p. 350, pl. 17, figs. 1, 2 (1868). For generic reference see Foerste, Notes on American Paleozoic Cephalopods, Jour. Sci. Lab., Denison Univ., vol. 20, p. 255, pl. 29, figs. 1 A, B, C (1924).

Conch subfusiform, convexly curved along its ventral outline. Its dorsal outline is concave along the greater part of the phragmacone, but convexly gibbous along the upper part of the phragmacone and the lower part of the living chamber, usually be-

coming slightly concave again toward the aperture. The cross section is depressed dorsoventrally, the dorsal side being slightly flatter than the ventral one. The median part of the ventral margin of the aperture curves downward moderately, forming a shallow hyponomic sinus. The sutures of the septa slope slightly downward ventrally in most species though this slope is accentuated in others. The siphuncle is located near the ventral wall of the conch but is not in contact with the latter. Its segments usually are barrel-shaped within the camerae though abruptly contracted at the septal necks.

Most of the species here described under *Amphicyrtoceras* are typical of the genus. However, in *Amphicyrtoceras reedsi* the conch is relatively slender and strongly curved lengthwise, and its maximum dorsoventral diameter is a little below midheight of the living chamber. However, the conch has not reached its gerontic stage of growth, and it is possible that at this stage of growth the base of the living chamber would be located at its present maximum dorsoventral diameter.

#### 25. *Amphicyrtoceras bownockeri* new species

*Plate 37, figures 1 A, B, C; plate 36, figure 2*

The holotype is 82 millimeters long in a direct line ventrally. The radius of curvature of its convex ventral outline is 70 millimeters along most of the phragmacone, changing to 40 millimeters along the top of the phragmacone and most of the living chamber, and lengthening to 60 millimeters at the top of the latter. The radius of curvature of the concave part of the dorsal outline along the greater part of the phragmacone is 50 millimeters, changing to 50 millimeters in a convex direction along the upper part of the phragmacone and the lower part of the living chamber, this outline becoming almost straight farther up. The dorsoventral diameter of the conch increases from 18 millimeters at its base to 41 millimeters at the base of the living chamber and then decreases to 27.5 millimeters just beneath the aperture. The corresponding lateral diameters are 18, 46, and 36 millimeters. The outward flaring of the ventral side of the living chamber at the

aperture may be due in part to the impression left in the matrix by the animal body above the level of the margin of the aperture. The septum at the base of the specimen has a concavity of 1.5 millimeters.

In a second specimen the surface of the shell is striated transversely, the striae being very low and flat, irregularly spaced, and numbering about 8 or 9 in a length of 10 millimeters. They are directly transverse dorsally, but curve slightly downward ventrally, forming a very shallow hyponomic sinus about 2 millimeters in depth and slightly angulate along its median part.

A third specimen exposes the sutures of the camerae. Its lateral diameter is 46 millimeters and 11 camerae occupy a corresponding length ventrally. The sutures of the septa are almost straight and rise only slightly in a ventrad direction.

A fourth specimen apparently preserves an impression of the exterior of the animal within the upper part of the living chamber and immediately above.

Occurrence: Hillsboro, Ohio, at the Trimble quarry, at the eastern end of the abandoned railroad project, near the north-eastern margin of the city; in the Peebles dolomite.

U. S. National Museum, no. 81827.

Remarks.—This species is characterized by its relatively small size, its strong curvature lengthwise, and its rapid rate of enlargement along the phragmacone. Its greatest diameter is at or slightly above the base of the living chamber.

## 26. *Amphicyrtoceras grimsbyense* new species

*Plate 38, figures 3 A, B*

1866. *Oncoceras pettiti* Billings. Cat. Sil. Foss. Anticosti, Geol. Surv. Canada, p. 86, fig. 26, but not the accompanying description.

The length of the specimen here selected as the holotype of a new species is about 50 millimeters in a direct line. The radius of curvature of its convex ventral outline varies from 70 millimeters along the greater part of the phragmacone to 20 millimeters along the upper part of the phragmacone and the lower part of the living chamber, changing to 30 millimeters farther up.

The radius of curvature of its dorsal outline is 30 millimeters along almost all of the phragmacone where this outline is concave, then changes to 20 millimeters along the upper part of the phragmacone and the lower part of the living chamber where this outline is convex, and finally returns to 30 millimeters again along the upper part of this chamber where its outline is concave. The dorsoventral diameter of the conch enlarges from about 14 millimeters at its base to 30 millimeters at the base of the living chamber and then decreases to 21.5 millimeters at the aperture. The corresponding lateral diameter are 14, 31, and 24 millimeters. The height of the living chamber is 23 millimeters. Dorsally and dorsolaterally the vertical outlines of the upper part of this chamber are slightly concave. Along the median part of its ventral side the cast of the interior of the living chamber curves outward for a width of 10 millimeters, a height of 3 or 4 millimeters, and for a distance of about 1.5 millimeters beyond the general vertical outline of this part of the chamber. No part of the interior of the phragmacone is exposed. A trace of the siphuncle is seen at its base, near the ventral wall of the conch. The surface of the shell is striated transversely, the striae being approximately at right angles to the curving vertical axis of the conch, rising slightly in a ventrad direction near the aperture. The hyponomic sinus is indicated distinctly along the margin of the aperture ventrally.

Occurrence: Grimsby, Ontario; in the upper part of the Lockport dolomite.

National Museum of Canada, no. 2744 c.

Remarks.—Compared with typical *Amphicyrtoceras pettiti*, as described by Billings in the publication cited above, this specimen figured by him as belonging to the same species is much smaller in size, is less compressed dorsoventrally, and is more strongly curved lengthwise, especially along its ventral side. The strong contraction of the living chamber toward its aperture indicates that the conch had reached its gerontic stage of growth and was not merely a young individual of the species.

27. *Amphicyrtoceras orcas latum* var. nov.*Plate 35, figure 1*

The holotype exposes only the exterior of the shell of the phragmacone and of the basal part of the living chamber. Its length is 110 millimeters; at 20 millimeters beneath its top its dorso-ventral diameter is 54 millimeters and its lateral one is 65 millimeters. The living chamber evidently contracted toward the aperture as in other species of *Amphicyrtoceras*. The most striking feature of this specimen is its strong lengthwise curvature, especially near its base; its rapid rate of enlargement, especially along the part beginning 25 millimeters above its base; and its strong dorsoventral depression. The surface of the shell is ornamented by broad transverse striae which are visible also on the cast of the interior of the conch. The striae curve slightly downward along the median part of the ventral side of the specimen. The inner layers of the shell also show numerous vertical striae variable in width, which however are not visible on its surface. The thickness of the shell apparently equalled scarcely one third of a millimeter.

Racine, Wisconsin: from the Racine dolomite.

Illinois State Museum, no. 8381.

Remarks.—This specimen is of interest chiefly owing to the rapid lateral expansion of its phragmacone. Vertical striation of the surface of the shell is seen in some individuals of typical *Amphicyrtoceras orcas*, and occasionally occurs also on the inner layers of latter, but in the individual here figured they are unusually numerous and distinct.

28. *Amphicyrtoceras pettiti* (Billings)*Plate 39, figures 2 A, B*

1866. *Oncoceras pettiti* Billings. Cat. Sil. Foss. Anticosti, Geol. Surv. Canada, p. 86, but not the text figure 26.

The first of the three specimens described by Billings in the publication cited above here is selected as the holotype since it furnishes the most information. It is about 104 millimeters long in direct measurement, but about 120 millimeters or nearly

5 inches long when measured along its convex ventral outline. The living chamber is 50 millimeters long in direct measurement. Its convex ventral outline has a radius of curvature of 80 millimeters along almost its entire length, but reverses from convex to concave along the upper 18 millimeters of the length of the living chamber, at least along the cast of the interior of the conch. The curvature of its dorsal outline is moderately concave along midlength of its phragmacone, changing to slightly convex along the upper part of the phragmacone and the lower part of the living chamber, and then becoming concave again along the upper two thirds of this chamber. The dorsoventral diameter enlarges from 19 millimeters at its base to 44 millimeters at a point 6 millimeters above the base of the living chamber, and then diminishes to about 33 millimeters at the aperture, with a distinct intermediate contraction of this dorsoventral diameter along the cast of the interior of this chamber at an elevation between 30 and 35 millimeters above the base of the latter. In a lateral direction the diameter of the conch increases from 21 millimeters at its base to 56 millimeters at the base of the living chamber and to 59 millimeters at a point 15 millimeters farther up. From this point the lateral diameter decreases gently for a length of 10 millimeters, and then more strongly for an additional length of 5 millimeters, where its diameter is 50 millimeters. At a point 45 millimeters above the base of the living chamber its lateral diameter is reduced to 43 millimeters, changing to 40 millimeters within the interval of 3 millimeters intervening between the last point and the margin of the aperture. Above the level of 35 millimeters above the base of the living chamber the interior of the wall of the conch appears to have been thickened conspicuously, thus accentuating here the rate of decrease in the dorsoventral and lateral diameters of the cast of the interior of this chamber toward the aperture. The margin of this aperture rises gently from the dorsal toward the ventral side of the conch. About 3 millimeters above the base of the living chamber the cast of the interior of the conch is sharply angulate in a transverse direction. Ten camerae still are attached to this chamber. The uppermost of these is conspicuously shorter than

the camerae immediately beneath. Of these camerae 6.5 occur in a length equal to the dorsoventral diameter of the conch. The sutures of the septa slope downward in a ventrad direction along the lower part of the phragmacone, becoming directly transverse at the top of the latter. The concavity of the septa is moderate. The siphuncle is exposed at the base of the specimen and also at its passage through the third septum above this base where the specimen is broken across. The cast of the interior of the phragmacone is marked by low vertical ribs, 10 occurring in a width of 25 millimeters, closely resembling those shown by the type of *Amphicyrtoceras laterale*. These ribs are indicated distinctly as far up as the transverse angulate ridge occurring a short distance above the base of the living chamber, and very faintly discernible even above the latter as far as the level where the thickening of the inner surface of the wall surrounding this chamber begins. National Museum of Canada, no. 2744.

The second of the three specimens described by Billings is numbered 2744 b. Its siphuncle is exposed in the second and third camerae above its base, and presents all the characters, including form, size, and location, of *Amphicyrtoceras orcas* (Hall) and *Amphicyrtoceras laterale* (Hall). The surface of its shell is traversed transversely by low and broad striae, about 13 in a length of 20 millimeters on its lateral sides, and these are crossed by a few obscure vertical lines.

The third specimen described by Billings, no. 2747a, may be merely a depauperate individual of this species. The margin of its aperture forms a broad and shallow hyponomic sinus about 2 millimeters deep. Earlier stages of this sinus are indicated also by the transverse striae which curve moderately downward on the ventral side of the conch, locating former outlines of a broad and very shallow hyponomic sinus.

Occurrence: Grimsby, Ontario; from the upper part of the Lockport.

National Museum of Canada, no. 2744, 2744b, and 2744a, in the order described by Billings.

Remarks.—Compared with *Amphicyrtoceras orcas* (Hall), from the Racine of Wisconsin, the conch of *Amphicyrtoceras pettiti* is

smaller, with a shorter living chamber and a more rapidly enlarging phragmacone; its camerae are relatively shorter. Compared with *Amphicyrtoceras laterale* (Hall), it agrees more nearly in size, but the rate of enlargement of the phragmacone is larger also in this case and the height of the camerae is less. Compared with *Amphicyrtoceras williamsi* Foerste, the conch appears more slender on lateral view, its living chamber relatively taller, and the gibbous part of its dorsal outline less conspicuous. Compared with *Amphicyrtoceras bownockeri* Foerste, the camerae are conspicuously longer and less numerous.

29. *Amphicyrtoceras reedsi* new species

Plate 36, figures 3 A, B, C

The holotype consists of a living chamber to which 13 camerae still are attached. Its total length in a direct line equals 74 millimeters, 33 millimeters of this length belonging to the living chamber. The radius of curvature of its convex ventral outline changes from 60 millimeters along the phragmacone to 40 millimeters along the living chamber. The radius of curvature along its concave dorsal outline is 50 millimeters along the phragmacone and the lower part of the living chamber, becoming slightly convex along the middle third of the latter and faintly concave again toward the aperture. The conch is depressed dorso-ventrally, the dorsoventral diameter at the base of its living chamber being 23.5 millimeters and the corresponding lateral diameter 27 millimeters. Its maximum lateral diameter at 8 millimeters above the base of the chamber is 29 millimeters. Farther up, the living chamber contracts, especially laterally but also slightly dorsally, resulting in the outline characteristic of species of *Amphicyrtoceras*. Toward the apical end of the conch its cross section becomes more nearly circular. The sutures of the septa are directly transverse without conspicuous saddles or lobes. The siphuncle is exposed along the upper three camerae within one millimeter of the ventral wall of the conch. Its segments attain a diameter of 3.6 millimeters within the camerae, narrowing to 2.2 millimeters at the septal necks. The latter are very short, scarcely half a millimeter in length.

Occurrence: Waukesha, Wisconsin; from the Racine dolomite. American Museum of Natural History, no. 2112 B. Named in honor of Dr. Chester A. Reeds.

Remarks.—This species is characterized by its slender form, its conspicuous lengthwise curvature and the gibbosity of the dorsal side of the conch at midheight of the living chamber.

30. *Amphicyrtoceras welchi* new species

Plate 35, figures 4 A, B

The holotype is about 62 millimeters long. Its convex ventral outline has a radius of curvature of 50 millimeters along almost its entire length, changing to faintly concave toward the aperture. Its dorsal outline has a radius of convex curvature of about 70 millimeters, changing to distinctly concave at 8 millimeters beneath the aperture. The maximum dorsoventral diameter is 45 millimeters, the lateral one being 47 millimeters, both being about 10 millimeters above the base of the living chamber. The phragmacone enlarges rapidly. Beneath its aperture the living chamber is strongly constricted, the maximum constriction being about 10 millimeters beneath. This constriction is most strongly defined laterally, and least strongly ventrally, the constriction on its dorsal side being intermediate. The sutures of the septa are directly transverse to the curving vertical axis of the conch. The siphuncle is located 1.5 millimeters from the ventral wall of the conch at the lower end of the specimen, this distance increasing to 2 millimeters at the top of the phragmacone. The segments of the siphuncle enlarge to a diameter of about 3 millimeters within the camerae.

Occurrence: Wilmington, Ohio, from the Moodie quarry; in the Cedarville dolomite.

Wilmington College, in the collection of Dr. L. B. Welch.

Remarks.—This species is characterized by the rapid rate of enlargement of its phragmacone, its relatively rapid lengthwise curvature ventrally, and its moderate depression dorsoventrally. Among species of *Amphicyrtoceras* already described the holotype of this species is characterized by the rapid lateral expansion of its phragmacone, the shortness of its living chamber, and the

prominence of the gibbosity of its dorsal outline along the top of the phragmacone and the lower part of its living chamber.

31. *Amphicyrtoceras williamsi* new species

*Plate 37, figures 3 A, B, C*

1919. *Poterioceras* sp., Williams, Geol. Surv. Canada, Memoir 111, pl. 26, figs. 2, 3, 4.

The holotype is about 92 millimeters long and consists of a living chamber to which 7 camerae still are attached. Its ventral outline originally had a radius of convex curvature of 100 millimeters for a length of 50 millimeters above its base, above which it changes to 60 millimeters for a length of 27 millimeters and then reverses to a radius of curvature of 70 millimeters in a concave direction for the remainder of its length. The lower part of its dorsal outline is faintly concave, changing to convex for the greater part of its length, the radius of this convexity being 150 millimeters, and its maximum being about 40 millimeters above the base of the specimen. Along the upper 20 millimeters of this outline the curvature is concave with a radius of 60 millimeters. This concave part extends around the entire circumference of the upper part of the living chamber, and originally the shell was thicker here so that the concavity was less pronounced along the surface of the shell than on the cast of the interior of the conch. The maximum dorsoventral diameter is 50 millimeters and the maximum lateral one is 57 millimeters, both being 10 millimeters above the suture at the base of the living chamber. On the ventral side of the living chamber the margin of the aperture curves gently downward, locating the shallow hyponomic sinus. The middle 5 of the 7 camerae occupy a length of 34 millimeters ventrally. The segments of the siphuncle attain a diameter of 7 millimeters within the camerae, where they are barrel-shaped, contracting abruptly at the septal necks to 2.5 millimeters. The striae on the surface of the shell are low and rather distant from each other. Dorsally they are directly transverse, but ventrally they curve gently downward. On weathered areas faint vertical striae also are present.

Occurrence: Near Warton, Ontario; from the Guelph dolomite. National Museum of Canada, nos. 5133, 5133a, 5134.

Remarks.—Compared with *Amphicyrtoceras laterale* (Hall) the apical angle of enlargement is larger, the living chamber is shorter, and the walls of the living chamber are more convergent toward the aperture. Compared with *Amphicyrtoceras bownockeri* the Warton species described here is larger, less curved lengthwise, and has a smaller apical angle.

**32. *Amphicyrtoceras* (?) *sauridens* Clarke and Ruedemann**

1903. *Poterioceras sauridens* Clarke and Ruedemann. Guelph Fauna in the State of New York; memoir 5, p. 93, pl. 14, figs. 1–19.

The dorsoventral outline of all the specimens figured on plate 14 of the publication cited above is identical with that of typical *Amphicyrtoceras*. However, the segments of the siphuncle of the specimen represented by figs. 10 and 11 do not have the barrell-shaped vertical outlines characteristic of that genus.

On the other hand, the living chamber represented by figs. 13 to 16 on pl. 13 appears to have a nummuloidal segment of the siphuncle attached to its base but it is not certain whether the dorsal outline of the conch was concave or gibbous along the base of the living chamber and the top of the phragmacone.

The eight specimens represented by figs. 1–5 and 10–19 on plate 14 are numbered in the same order from 5142 to 5149 in the New York State Museum, while that represented by figs. 13–16 on pl. 13 is numbered 5141.

**STREPTOCERAS Billings**

Genotype: *Streptoceras janus* Billings. Cat. Sil. Foss. Anticosti, Geol. Surv. Canada, p. 88, fig. 28, 1866. For figure of genotype see Foerste, Actinosiphonate, Trochoceroid and other cephalopods, Jour. Sci. Lab. Denison Univ., vol. 21, p. 334, pl. 47, figs. 1 A, B, C (1926).

Conchs similar in form and structure to typical *Amphicyrtoceras* but differing in the outline of the aperture. The dorsal side and the two ventrolateral sides are sufficiently flattened

toward the upper part of the living chamber to give the aperture a more or less distinctly triangular outline. The dorsal side of this outline is slightly convex, but the ventrolateral parts are slightly concave, leaving rounded dorsolateral lobes and a more narrowly rounded hyponomic sinus. At the hyponomic sinus the ventral outline of the conch curves conspicuously outward in the genotype *Streptoceras janus*, but only slightly outward in *Streptoceras heros* Billings, from the same locality and horizon.

### 33. *Streptoceras janus* Billings

1866. *Streptoceras janus* Billings. Cat. Sil. Foss. Anticosti, Geol. Surv. Canada, p. 88, upper one of the two text figures numbered 28.

1926. *Streptoceras janus* Foerste. Actinosiphonate, trochoceroid, and other cephalopods; Denison Univ., Jour. Sci. Lab., vol. 21, p. 354, pl. 47, figs. 1 A, B (1926).

The holotype is about 127 millimeters long in direct measurement. Its ventral outline has a radius of convex curvature of 90 millimeters along the phragmacone, decreasing moderately at the junction of the phragmacone and living chamber, and then returning to 90 millimeters along the lower 45 millimeters of the length of the living chamber, above which this ventral outline reverses to concave for a length of 13 millimeters with a radius of 25 millimeters, this upper part outlining the ventral side of the conch immediately beneath the hyponomic sinus. The dorsal outline of the conch is distinctly concave along the lower 10 millimeters of its length, then becomes slightly convex to a point about 35 millimeters above the base of the living chamber, and reverses to concave with a radius of 30 millimeters as far as the aperture. The dorsoventral diameter increases from 22 millimeters at the base of the specimen to 52 millimeters a short distance below the base of the living chamber, then decreases to 38 millimeters about 9 millimeters beneath the aperture, and enlarges to at least 43 millimeters at the top. The corresponding lateral diameters are 23, 59, 39, and 40 millimeters. Along its dorsal side the living chamber is 53 millimeters in height. Along

its upper part the interior of the shell was thickened by an annular deposit varying in vertical height from 25 millimeters dorsally to 30 millimeters ventrally, but only 1 or 2 millimeters thick. The outline of the aperture is triangular, its dorsal side being flattened; corresponding flattening is shown also by its ventrolateral sides which converge at an angle of about 65 degrees. All angles of the aperture are broadly rounded, the ventral one being elongated into a hyponomic sinus 10 millimeters long, with sides converging at an angle of 50 degrees. Judging from the cast of the interior of the living chamber the upper part of its shell curved distinctly outward at all three angles, this outward curvature equalling 2 millimeters at the dorsolateral angles and 3 millimeters at the hyponomic sinus. The phragmacone consists of 12 camerae, of which the uppermost one is only 1 or 2 millimeters in height. The sutures of the septa curve only slightly downward laterally, rising moderately in a ventrad direction. The concavity of the septa increases from 3 millimeters at the base of the specimen to 10 millimeters at the top of the phragmacone. The siphuncle is less than one millimeter from the ventral wall of the conch, and increases in diameter from 2.5 millimeters at the base of the specimen to 6 millimeters at the fourth camera beneath the living chamber. Its general form is barrel-shaped, but strongly constricted at the septal necks. Where the diameter of the siphuncle is 6.4 millimeters that of the septal necks is 3.2 millimeters. These necks are slightly longer than half a millimeter. The surface of the shell is nearly smooth, there being traces of transverse striae, similar to those of *Amphicyrtoceras orcas*.

Occurrence: Grimsby, Ontario; in the upper part of the Lockport formation.

National Museum of Canada, no. 2748.

Remarks.—The outward curvature of the ventral side of the conch at the hyponomic sinus is the most distinctive feature of this species, being much more conspicuous than that of *Streptoceras heros* Billings from the same locality and horizon.

34. *Streptoceras heros* Billings*Plate 41, figures 1 A, B*

1866. *Streptoceras Heros* Billings. Cat. Sil. Foss. Anticosti, p. 89.

The first of the three specimens described by Billings is the only one at hand and here is regarded as the holotype. This specimen is 152 millimeters in length when measured in a straight line from the highest margin of the aperture, but nearly 173 millimeters in length when measured along its ventral outline. The radius of curvature of its convex ventral outline is about 130 millimeters along the greater part of the length of the conch, both along the phragmacone and the living chamber, but decreases to 80 millimeters in the vicinity of their junction. Its dorsal outline is faintly convex along the living chamber. Its maximum convexity apparently is at the base of this chamber and the top of the phragmacone, becoming slightly concave about 50 millimeters below their junction. At 70 millimeters below the base of the living chamber dorsally the dorsoventral diameter of the conch is 25 millimeters, increasing to 68 millimeters at the base of this chamber, and then decreasing to 48.5 millimeters at the aperture. At the base of the specimen its cross section appears approximately circular. At the base of the living chamber its lateral diameter is 70 millimeters, and at the aperture it is estimated at 60 millimeters. From this it is evident that the dorsoventral depression of the conch is readily evident only along the upper part of the living chamber. At the aperture the cross section of the conch is approximately triangular. Along its dorsal side the radius of convex transverse curvature is 60 millimeters, changing to 10 millimeters along the dorso-lateral part of the aperture. Ventrolaterally this curvature reverses to concave with a radius of 60 millimeters, the two sides converging strongly in a ventrad direction and then changing to convex with a radius of 10 millimeters along the hyponomic sinus. Dorsally and ventrolaterally the margin of the aperture rises 3 or 4 millimeters above the level of its two dorsolateral lobes, and then curves downward toward the hyponomic sinus to about the

same level as the dorsolateral lobes or slightly lower. At this hyponomic sinus the ventral outline of the conch curves but slightly outward, but the sinus itself is about 25 millimeters wide and 10 millimeters deep. The length of the living chamber is 70 millimeters. The suture of the septum at the base of the living chamber possibly slants downward a little in a ventrad direction. The concavity of this septum equals 15 millimeters. The siphuncle here equals 8 millimeters in diameter and is 4 millimeters distant from the ventral wall of the conch. The thickness of the shell equals fully one millimeter along the living chamber. Its surface is transversely striated, these striae slanting downward in a ventrad direction so as to reach a level about 10 millimeters lower along the median part of the ventral side of the conch than along its lateral outlines. At earlier stages of growth the hyponomic sinus was very shallow and its median part was subangularly rounded. The transverse striae are low and broad and tend to be slightly more distinct at rhythmic intervals of about 3 millimeters, resulting in a faintly banded appearance.

Occurrence: Grimsby, Ontario, about 25 miles west of Niagara Falls in Canada; in the Lockport member of the Niagaran, probably from some point along Twenty mile Creek.

National Museum of Canada, no. 2747.

#### **RHOMBOCERAS** new genus

Genotype: *Rhomboceras welchi* Foerste.

Conch strongly depressed dorsoventrally, elliptical in cross section. Ventral outline more evenly convex, dorsal outline gibbous at the base of the living chamber and the top of the phragmacone, somewhat as in *Amphicyrtoceras*, of which it may be a derivative. The lateral outline is subrhomboidal, its greatest diameter in this direction being at the third camera beneath the living chamber. Sutures of septa nearly straight along the lower part of the phragmacone but curving strongly downward at its top. The upper two sutures tend to straighten slightly along the median part of their course ventrally.

Only the genotype is known. A somewhat similar form, but

lenticular in cross section, is presented by the species described by Hall under the name *Trochoceras (Gonioceras) pandum* from the Schoharie grit in Albany county, New York.

35. **Rhomboceras welchi** new species

*Plate 38, figures 1 A, B, C*

The holotype is about 70 millimeters long, 33 millimeters of this length belonging to the living chamber when measured from the lowest part of the suture at its base. In a lateral direction the conch enlarges at an angle of 55 degrees as far as the base of the third camera beneath the living chamber. Here the lateral outline becomes convex with a radius of curvature of 30 or 40 millimeters to a point about 10 millimeters above the base of the living chamber and then reverses to concave as far as the aperture. The lateral diameter increases from 23 millimeters at the base of the seventh camera beneath the living chamber to 42 millimeters at midheight of the third camera beneath the latter and then decreases to 30 millimeters at 10 millimeters beneath the aperture and to 28 millimeters at the aperture. The convex ventral outline has a radius of curvature of 70 millimeters along the lower 30 millimeters of its length, changing to 50 millimeters along the following 30 millimeters, and reversing to concave along the upper 10 millimeters. The dorsal outline is straight or faintly concave to the base of the second camera beneath the living chamber, and then has a radius of curvature of 25 millimeters to a point 13 millimeters beneath the aperture, above which the curvature reverses to concave. The dorso-ventral diameter of the conch enlarges from 17 millimeters at the base of the seventh camera beneath the living chamber to 34 millimeters at the base of this chamber, and then decreases to 22 millimeters about 8 millimeters beneath its aperture and to approximately 20 millimeters at the aperture. The relative amount of depression dorsoventrally evidently increases with age. Along the lower part of the phragmacone the sutures of the septa are almost straight and directly transverse dorsally, and curve only slightly downward ventrally. Toward the upper part of the

phragmacone however the sutures of the septa curve increasingly downward on both of these sides, the depth of this curvature equalling 8 millimeters dorsally and 10 millimeters ventrally. The siphuncle is located near the ventral wall of the conch. At the base of the specimen its lateral diameter appears to be 4 millimeters, but nothing definite is known of its structure.

Occurrence: Wilmington, Ohio, from the Moodie quarry; in the Cedarville dolomite.

Wilmington College, in the collection of Dr. L. D. Welch.

Remarks.—The nearest approach to anything resembling the Wilmington species here described is the form described as *Amphicyrtoceras tantalum* by Foerste from the lower part of the Peebles dolomite at Hillsboro, Ohio. However, in the Wilmington species the downward curvature of the sutures of the septa both ventrally and dorsally is much more accentuated. Both species differ from typical *Amphicyrtoceras* in attaining their greatest lateral diameters at a level distinctly below the base of the living chamber.

#### URANOCERAS Hyatt

Genotype: *Cyrtoceras uranus* Barrande. *Système silurien de la Bohême*, vol. 2, pt. 1, p. 644, 1867; pl. 196, figs. 12–18 (1866).

In typical *Uranoceras*, as indicated by its genotype, the conch is strongly curved lengthwise but tapers so rapidly toward its apical end that it is improbable that the latter ever was in contact with the later formed portion of the conch. The sutures of the septa curve slightly downward laterally. The location of the siphuncle is only slightly ventrad of the center of the conch. Its segments are broadly cylindrical along most of their length within the camerae but contract strongly at the septal necks.

The reference of the Wilmington species *Uranoceras* (?) *perdistensum* to this genus is merely provisional, the similarity being confined to the strongly curved form of its living chamber, the conch evidently being cyrtconic, and its rate of tapering rapid in an apical direction. The sutures of its segments are almost straight laterally, and nothing is known of the location of its siphuncle.

36. *Uranoceras* (?) *perdistensum* new species*Plate 30, figure 1*

The holotype consists of a living chamber to which the upper 8 camerae still are attached. This conch is strongly curved and enlarges with unusual rapidity. Its cross section can not be determined with accuracy since only the left half of the conch is well preserved, but apparently it is nearly circular along its lower part, becoming moderately compressed laterally along the living chamber with a slight flattening of its ventrolateral sides. The specimen in its present condition is 120 millimeters in length along its ventral outline, 45 millimeters of this length belonging to the living chamber; the original length of this chamber being at least 8 millimeters greater. The radius of curvature of its convex ventral outline increases from 30 millimeters along the lower 33 millimeters of its length to 60 millimeters along the next 50 millimeters, and to 80 millimeters at its top. The radius of its concave ventral outline on the contrary increases from 12 to 15 millimeters. The dorsoventral diameter of the conch increases from 18.5 millimeters at its base to 43 millimeters at the base of the living chamber, and originally it equalled about 82 millimeters at a point 55 millimeters above the base of this chamber ventrally. The uppermost camera is 14 millimeters in length, the underlying ones having lengths of 12, 11, 10, 8, 6, 6, and 5 millimeters in descending order. About 18 millimeters above the base of the living chamber ventrally there is a faint transverse groove as though the animal at the time of its death was about to add another camera to its phragmacone. At least, there is no evidence that the conch had reached its gerontic stage of growth. No trace of the siphuncle remains. The specimen is a cast of the interior of the conch and no trace of surface markings is preserved, and its surface is assumed to have been smooth.

Occurrence: Wilmington, Ohio, from the Moodie quarry; in the Cedarville dolomite.

U. S. National Museum, no. 89823.

Remarks.—This conch resembles *Uranoceras* in its rapid rate of enlargement, its strong curvature, and its relatively distant

septa. However, the sutures of the septa are straighter laterally. In typical *Uranoceras* the siphuncle is subcentral, being a short distance ventrad of the center of the conch and its segments are elongated vertically into an oblong outline. In the absence of any knowledge as to the location of the siphuncle in this Wilmington specimen its reference to *Uranoceras* is only tentative.

### GALTOCERAS new genus

Genotype: *Cyrtoceras arcticameratum* Hall.

Conch slender, moderately curved, depressed dorsoventrally. Sutures of septa straight and directly transverse to the curving vertical axis of the conch. Siphuncle located on the convex side of the conch, almost in contact with its ventral wall; small, its segments nearly globular in form but truncated at top and bottom.

#### 37. *Galtoceras arcticameratum* (Hall)

Plate 29, figures 3 A, B, C

1852. *Cyrtoceras arcticameratum* Hall, Pal. New York, vol. 2, p. 349, pl. 84, figs. 7a-d.

1903. *Cyrtoceras arcticameratum* Clarke and Ruedemann, Guelph fauna in the State of New York, mem. 5, New York State Museum, p. 87, pl. 15, figs. 1, 2 (not pl. 16, figs. 1-5).

Conch curving moderately lengthwise, the radius of curvature of its convex ventral outline being 75 millimeters, that of its concave dorsal outline being almost the same. The rate of enlargement is small, its dorsoventral diameter increasing in one specimen from 7 to 12 millimeters in a length of 47 millimeters, and in another specimen from 8 to 14 in a length of 65 millimeters. The cross section of the conch is depressed dorsoventrally, the dorsoventral diameter of one specimen being slightly less than 13 millimeters, while its lateral one is slightly over 14 millimeters, the depression being due chiefly to the flattening of its dorsal side. Both the smaller and the larger specimen figured by Hall have 40 camerae. Where the diameter of the conch is 8.5 millimeters there are 9 camerae in a length of 10 millimeters; at a diameter of 12 millimeters there are 6.3 camerae in this length, and at a

diameter of 14 millimeters there are 5.5 camerae. The sutures of the septa are straight and directly transverse to the curving vertical axis of the conch. The concavity of the upper septa is scarcely more than 1 millimeter. The siphuncle is almost in contact with the ventral wall of the conch. Near the top of the larger specimen it enlarges to almost 3 millimeters within the camerae, narrowing to slightly over 2 millimeters where in contact with the septa, its passage through these septa probably being considerably smaller. The appearance of the segments of the siphuncle is more nearly truncated globular than nummuloidal.

Occurrence: Galt, Ontario; from the Guelph dolomite.

American Museum of Natural History, no. 2236.

Remarks.—The specimens figured by Clarke and Ruedemann on plate 15 of the publication cited above is closely similar to the genotype; those figured on their plate 16 are more strongly curved lengthwise and have longer camerae.

### 38. *Galtoceras ruedemanni* new species

1903. *Cyrtoceras arcticameratum* Clarke and Ruedemann. Guelph Fauna in the state of New York; Memoir 5, New York State Museum, p. 87, pl. 16, figs. 1-5 (not pl. 15, figs. 1, 2).

Conchs differing from typical *Cyrtoceras arcticameratum* Hall in their stronger lengthwise curvature and taller camerae.

Occurrence: Rochester, New York; in the Guelph dolomite.

### DISCOSORUS Hall

Genotype: *Discosorus conoideus* Hall. Palaeontology of New York, vol. 2, p. 99, pl. 28, figs. 13 a-c (1852).

Siphuncle distinctly curved lengthwise, with its convex outline in contact with the ventral wall of the conch. The rapid rate of enlargement of this siphuncle indicates a similar rapid rate of enlargement of the conch. The segments of the siphuncle rise in a ventrad direction. Their form is nummuloidal, low and broad. Their dorsal and lateral vertical outlines are evenly rounded, but their ventral part thins in a ventrad direction, chiefly owing to the flattened adnation of the lower face of these segments to the upper surface of the septa immediately beneath,

so that the vertical thickness of these segments decreases on approaching the ventral wall of the conch.

The validity of using the New York specimen, rather than the Michigan one published under the same name, as the type of the species *Discosorus conoideus* is discussed under the description of that species.

The northward range of species belonging to this genus is indicated by the forms described by Dr. G. W. Lee from the vicinity of Prince Regent Inlet, which extends between Port Bowen on Cockburn Land on the east and North Somerset Land, in the area northwest of Baffin Land. These forms were described under the names *Discosorus borealis* Lee and *Discosorus regularis* Lee (11). Their horizon probably corresponds to that of the Manistique of northern Michigan.

### 39. *Discosorus conoideus* Hall

1851. *Discosorus conoideus* Hall. In Foster and Whitney's Report on the geology of the Lake Superior Land District, pt. 2, p. 222 (not figs. 2, 3, on pl. 34, later used as holotype of *Discosorus halli* Foerste).

1852. *Discosorus conoideus* Hall. Pal. New York, vol. 2, p. 99, pl. 28, figs. 13 a-c.

1924. *Discosorus conoideus* Foerste. Contrib. Mus. Geol. Univ. Michigan, vol. 2, no. 3, p. 68, pl. 7, figs. 1 A, B, C.

The description of *Discosorus conoideus* in Foster and Whitney's report is as follows:

*Discosorus conoideus*, Palaeontology of N. Y., vol. II, p. 99, Plate XXVIII, figure 13, a, b, c.

A conical body composed of a series of rings or discs, with rounded outer edges, and flattened above and below. Each succeeding ring, or disc, increases in size from the apex towards the base.

These discs are composed of a thick crust, or shell, having a fibrous structure, which radiates from a small, central, tubular cavity, or space, filled by a different kind of material. This cavity may, perhaps, communicate with the internal, conical cavity, formed within the entire series of rings. *The structure of the ring, in specimens of this fossil from New York, resembles more nearly that of the Belemnite than anything else with which I am acquainted. The specimens from Lake Michigan afford no new facts regarding the structure of this fossil. One of the specimens has the two broader discs crushed, giving them apparently an abruptly in-*

creased diameter; but this appearance is entirely accidental. The oblique direction of the discs and the curved form of the specimens are, in like manner, due to pressure. The other specimen has the edges of the discs worn down, the interior being crystallized, leaving only a thin exterior shell. This crystallized interior does not represent the cavity before alluded to, but is the substance of the thick shell, or crust, crystallized and partially removed, leaving a cavity.

These fossils were first noticed by Dr. Bigsby, on Drummond's island, and were described and figured in the geological transactions before cited, (12) but without a name, and, so far as I know, they have remained without farther notice, until the description cited above. *I am unable to find any characters by which to separate the species, now described, from those found in the Clinton group in New York.*

*Geological Position and Locality.* The specimens figured were found with Huronia at Orthoceras Point, in limestone of the Niagara period; and also in the same rock on Drummond's island.

Orthoceras Point is the promontory forming the southern boundary of Portage Bay, 20 miles southwest of Manistique and almost 12 miles from Point Detour, on the northwestern shore of Lake Michigan, in the state of Michigan. The formation there exposed is the Manistique, and this probably also was the horizon of those figured by Bigsby from Collier's Harbor on the southwestern margin of Drummond island. The specimen mentioned as coming from the Clinton group of New York was found at Lockport in that state, probably in the Reynales limestone member of that group.

It is evident that Hall regarded the New York specimen as the type of his species *Discosorus conoideus* and that the description of the latter was written first, though not published first. Moreover, he regarded both as belonging to the same species and was unable to discover specific differences. This is indicated by the sentences here underscored in his original description. Had he not mentioned the New York specimen in the Foster and Whitney report the Michigan specimen undoubtedly would have become the type, notwithstanding Hall's original intention. But his description of *Discosorus conoideus* in the Foster and Whitney report practically covers both specimens and both are mentioned and this makes it possible for a later author to select either the Michigan or the New York specimen as type of the species, and in 1924 the New York specimen was selected.

This was not done without reason. Two specimens were figured by Hall in the Foster and Whitney report under *Disco-*

*sorus conoideus*. The original of fig. 2 is preserved in the American Museum of Natural History; the original of fig. 3 is lost. The first I have named *Discosorus halli*. The second may belong to *Discosorus ehlersi*, but this can not be determined beyond doubt in the absence of the specimen itself. Unfortunately the exact orientation of the first specimen is unknown. Apparently it is a weathered vertical section of a siphuncle so oriented as to preserve only its lateral outlines. However, for purposes of discrimination from some of the species referred to the later described genus *Stokesoceras* it is the dorsoventral outline which must be known. Moreover the exact rate of enlargement of this Michigan specimen, and the amount of inclination of its segments with reference to the central axis of the siphuncle are uncertain. Under these circumstances the selection of the original of fig. 3 of the Foster and Whitney report as the genotype would leave this genus on a very insecure foundation, while the New York specimen furnishes definite information regarding all the characters here mentioned. It is fortunate, therefore, that the inclusion of the New York specimen in the description published in the Foster and Whitney report makes it possible to adopt the original intention of the author, and to select the New York specimen as the type.

In Bigsby's paper entitled Notes on the Geography and Geology of Lake Huron, published in vol. 2 of the Transaction of the Geological Society (of London) in 1824, fig. 7 on plate 30 represents a typical *Discosorus*. Figure 4 apparently is similar to the larger specimen figured by Hall from Michigan under *Discosorus conoideus* and later used as the holotype of *Discosorus halli*. Figure 6 is similar to *Discosorus ehlersi* Foerste described in 1924 in Contributions from the Museum of Geology, Univ. of Michigan, vol. 2, p. 69. Figure 3 is similar to *Stokesoceras engadinense* Foerste published in the same paper. The latter also contains reproductions of figures 3 and 4 of those published by Bigsby, and a photograph of the original of his fig. 6, but not of his fig. 7. It is scarcely necessary to state that the reference of *Discosorus halli* to the genus *Discosorus*, as established on the New York specimen, is merely tentative, in the absence of conclusive information of the features noted above.

The New York specimen is numbered 1580 and the Michigan specimen is numbered 2115 in the American Museum of Natural History.

#### 40. *Discosorus austini* new species

*Plate 34, figures 1 A, B; 4 A, B, C; plate 35, fig. 5*

The holotype is approximately 100 millimeters long. Of this length 70 millimeters is assumed to belong to the phragmacone and 30 millimeters to the living chamber. The phragmacone is represented only by the siphuncle and the uppermost camera, and of the living chamber only the lower part remains. Of all of these parts only the ventral side is fully exposed. At the uppermost camera the cross section of the conch has a radius of curvature of about 23 millimeters for a width of 40 millimeters along the median part of its ventral side, changing to about 40 millimeters ventrolaterally. From this it is estimated that the dorsoventral diameter of the conch here was 69 millimeters and its lateral diameter about 57 millimeters. The ventral halves of the segments of the siphuncle are fully exposed. These segments are broadly nummuloidal in form and the intervals between them apparently leave room only for the intermediate septa but not for septal necks. The upper surfaces of these segments evidently rose strongly toward the ventral outline of the phragmacone, forming angles of about 53 degrees with the latter. Dorsally the septa were in contact only with the lower faces of the segments of the siphuncle but ventrolaterally the marginal line of adnation of the septa to the segments rises obliquely in a ventrad direction so that a much smaller part of the height of these segments remains free from contact here. The lateral diameter of the third segment from the base of the siphuncle is 8 millimeters; that of the eighth segment is 31 millimeters. Only the lower face of the ninth segment is exposed, and this part has a lateral diameter of 33.5 millimeters. The dorsoventral diameters probably were a little longer in a direction parallel to the septa. The septum at the base of the uppermost camera is preserved for a short distance ventrolaterally on the right side of the conch.

Occurrence: Todd's fork, 2 miles north of Wilmington, Ohio; in the lower and thinner layers of the Dayton limestone member of the Clinton.

U. S. National Museum, no. 89824.

Remarks.—Of that part of the Todd's Fork specimen which extends above the top of the siphuncle only the lower 30 millimeters belong to the living chamber, the part farther up having been carved out of the matrix, but this lower part of the living chamber is sufficient to show the cyrtoconic form of the conch, the latter being compressed laterally, with the siphuncle in contact with the ventral wall of the conch.

A small fragment of a siphuncle, apparently corresponding to the sixth, seventh and eighth segment of the holotype just described, was found in the Dayton limestone of Adams county, Ohio. This specimen is of interest chiefly on account of the structure of its interior as exposed by a vertical dorsoventral section. It shows the peculiar hump at the bottom of the cavity occupying the upper part of the siphuncle. This differs in appearance from that illustrated by Foord (13) from the Manistique formation of Drummond Island, in the western part of Lake Huron in the species later described by Foerste (14) under *Discosorus ehlersi*, and also from the one more recently figured by Teichert (15) from corresponding strata on Cockburn Island under *Discosorus conoideus* Hall. An attempt to show the relative position of the fragment from Adams county within a more complete siphuncle is shown by figure 5 on plate 35.

U. S. National Museum, no. 81921 A.

Remarks.—The exact structure of the septal neck has not yet been determined in any species of *Discosorus*.

#### 41. *Discosorus perexpansum* new species

Plate 34, figures 5 A, B

The holotype consists of a fragment of a siphuncle 37 millimeters long on its ventral outline. It includes a considerable part of 4 segments and at its base the ventral margin of a fifth segment. The lateral diameter enlarges from 14.5 millimeters

at the second segment from the base to 32 millimeters at the uppermost segment, the interval being 18 millimeters in the present condition of the specimen, when measured along its ventral outline. Measured vertically to their upper flat surfaces the height of these segments increases from 4.5 millimeters at the second segment from the base to 7 millimeters at the fifth or top segment. The upper surface of the third segment from the bottom meets the ventral outline of the siphuncle at an angle of 45 degrees. This ventral outline has a radius of convex curvature of 70 millimeters. The septa are adnate to the lower surface of the segments of the siphuncle dorsally but ventrolaterally the marginal line of adnation rises in a ventral direction and the ventral side of these segments becomes flattened so as to produce a wedgeshaped dorsoventral vertical section along their ventral halves. The flattened surfaces of adnation to the septa exposed in the present condition of the specimen increase from a dorsoventral width of 6 millimeters at the second segment to 10 millimeters at the uppermost one. Viewed vertically to their upper flat surfaces these segments appear nearly circular in outline. The intervals between the segments appear just large enough for the intervening septa, these septa apparently being adnate both to the segments above and those beneath along the greater part of their adjacent surfaces.

Occurrence: Centerville, Ohio; from the Dayton limestone member of the Clinton.

U. S. National Museum, No. 81923.

Remarks.—The flattened area of adnation of the ventral side of the segments of the siphuncle to the septa immediately beneath is broader in this specimen than in any other known species of *Discosorus*. Possibly *Discosorus halli* is a vertical section in a lateral direction near the dorsal side of a siphuncle similar to this species.

#### 42. *Discosorus* cf. *ehlersi* Foerste

Plate 42, figures 2 A, B

1882. *Discosorus conoideus* Whitfield. Geology of Wisconsin, vol. 4, p. 299, pl. 20, fig. 6.

Conch apparently only slightly curved, its ventral outline being slightly convex and its dorsal outline being assumed to have been correspondingly concave. Along that part of the phragmacone preserved its rate of enlargement in a dorsoventral direction is about 35 degrees. At the top of the uppermost camera preserved its dorsoventral diameter is 33 millimeters. The cross section of the conch is only partially preserved, but apparently it was moderately compressed laterally. Where the dorsoventral diameter of the conch is 33 millimeters the underlying 6 camerae occupy a total length of 25 millimeters, the upper 3 occupying a length of 13 millimeters. A seventh camera, immediately beneath this series, apparently was shorter than the one at the base of the series, as far as this can be determined from the length of the segment of the siphuncle occurring at this level. Where the dorsoventral diameter of the conch is 28 millimeters the concavity of the septa is about 4 millimeters, and the dorsoventral diameter of the siphuncle is about 15 millimeters. The siphuncle evidently is large compared with the diameter of the conch. Only the lower 5 segments of the siphuncle are distinctly exposed both dorsally and ventrally, and these enlarge in diameter from 8.5 millimeters at the lowest segment to approximately 15 millimeters at the fifth segment. An attempt to expose the dorsal side of the three overlying segments suggests that the dorsoventral outline of this siphuncle resembled that of *Discosorus ehlersi* Foerste, from the Manistique member of the Niagaran as exposed on Drummond Island, in the northwestern part of Lake Huron. The segments of the siphuncle rise strongly in a ventrad direction, in conformity with the general slope of the septa. The ventral side of the siphuncle is about one millimeter distant from the ventral wall of the conch. The surface of the shell apparently was smooth.

Occurrence: From the railroad cut in section 2 at Ashford, in Fond du Lac county, Wisconsin; in the Lower Coral beds of the Niagara group, correlated by T. C. Chamberlin with the lower part of the Waukesha formation as exposed farther south in Wisconsin.

This specimen, figured by Whitfield, is preserved in the collec-

tions of the University of Wisconsin, and was kindly loaned by Prof. W. H. Twenhofel.

Remarks.—In typical *Discosorus* the ventral part of the lower face of each segment of the siphuncle is obliquely flattened, so that the ventral part of each segment becomes thinner on approaching its ventral margin. In *Discosorus ehlersi* Foerste, on the contrary, there is no conspicuous thinning of these segments ventrally.

In this respect the specimen figured by Whitfield from Ashford, Wisconsin, resembles *Discosorus ehlersi*, differing from the latter chiefly in the slightly shorter height of these segments.

#### 43. *Discosorus* (?) *lyonsense* new species

Plate 34, figures 2 A, B

The holotype consists of a part of a siphuncle 48 millimeters long, and includes 7 segments with a trace of an additional segment at its top. The radius of curvature of the convex outline of the lower 5 segments is 60 millimeters, this rate of curvature continuing apparently as far as the top of the part preserved. Along their curving ventral outline the 7 segments occupy a length of 43 millimeters, but in a direction perpendicular to their upper flat surfaces this distance is only 36 millimeters. These flat surfaces are practically parallel to each other and therefore meet the curving ventral outline at different angles. At the top of the fourth and fifth segments this angle is about 75 degrees. Dorsally and dorsolaterally the vertical outlines of the segments are evenly rounded, but ventrally they are in flattened contact with the ventral wall of the conch. Except along their outer margins successive segments are so close together that there appears room only for the intervening septa. Between the fourth and fifth segments of the siphuncle the passage of the siphuncle through the intervening septum is contracted to a diameter of about 11 millimeters, the diameter of the fourth segment being about 19 millimeters. Apparently an impression of part of the dorsal side of the conch, shown at the right of the siphuncle in fig. 2 A, is preserved; but if that is the case the siphuncle has

been displaced more or less from its original location within this conch. Apparently the dorsal outline of this conch was only slightly concave but nearly erect, deviating from the ventral outline at an average angle of about 30 degrees. Where the dorsoventral diameter of the siphuncle is 20 millimeters at the fifth segment the dorsal wall of the conch appears to have been 13 to 15 millimeters distant from the latter, but this is only an estimate.

Occurrence: Lyons, Iowa; probably in the lower part of the Hopkinton dolomite member of the Niagaran. Lyons is 4 miles north of Clinton, Iowa, and 21 miles northeast of Port Byron, Illinois.

U. S. National Museum, no. 7786.

Remarks.—Among species already described *Discosorus lyonsense* most closely resembles *Discosorus humei* Foerste (16) from the Lake Timiskaming area in Ontario, Canada, and *Discosorus remotus* Foord from Drummond Island in the northwestern part of Lake Huron. The reference of these species to *Discosorus* is only tentative. Compare also the second specimen described by Billings under *Orthoceras infelix* from the Jupiter formation of Anticosti (17).

#### 44. Structure of deposits within siphuncles of *Discosorus* and other genera

##### *Plate 37, figure 4*

In *Discosorus* a calcareous deposit lines the interior of the siphuncle. This deposit is thinnest at the septal necks and increases in thickness toward midheight of the individual segments of the siphuncle. Hall observed that the structure of this deposit is fibrous, and that the fibers are essentially vertical to the outer surface of the segments of the siphuncle. At the most prominent part of the segments laterally these fibers, in vertical sections, appear to radiate outward, and a similar radiation, but in an inward direction, takes place at the septal necks. The calcareous deposit thickens toward the lower end of the siphuncle and the sinuosities at the septal necks and within the connecting

rings gradually become weaker. Finally the lower part of the siphuncle becomes entirely filled, except along a tubular central part known as the endosiphotube. Originally this endosiphotube was merely the downward extension of the more or less funnel-shaped cavity formed by the calcareous deposits lining the interior of the siphuncle farther up. In many specimens the sinuosities along the walls of the funnel-shaped cavity within the siphuncle are still conspicuous. In others they are nearly obsolete, so that these cavities resemble the cavities occupying the uppermost endocones of *Holochoanoidea*. Teichert (18) has figured two such cases: one in a specimen of *Stokesoceras cf. engadinense* Foerste (fig. 4), and the other in the holotype of *Endodiscosorus foerstei* Teichert (fig. 8). Occasionally the deposit at the base of the funnel-shaped cavity becomes irregular and takes a more or less mammillate form. One case of this type was illustrated by Foord (19) another by Teichert (20), and a third is shown by fig. 4c on plate 34 of the present publication. Unfortunately, none of these vertical sections through the mammillae are accompanied by a transverse section showing whether the endosiphotube continues upward through this mammilla or is closed by the latter.

In the present paper the mammilla at the base of the funnel-shaped cavity within a siphuncle of *Discosorus* is shown in vertical section by fig. 4c on pl. 34. Another specimen, strongly weathered, and exposing the endosiphotube at its base is illustrated by fig. 4 on pl. 37. A third specimen, not figured, strongly weathered and including only a part of two segments, exposes the endosiphotube at its base. The upper one of these two segments was at least 18 millimeters in diameter. All three specimens were obtained at a locality a little over half a mile northeast of the Osman school which is 5 miles east of West Union, Ohio, and all probably belong to *Discosorus austini*, although this is not certain.

U. S. National Museum, nos. 81921a, 81922, and 81921b, in the order here described.

A fourth specimen, also referred to *Discosorus austini*, was obtained at the type locality of this species on Todd's Fork, 2

miles north of Wilmington, Ohio. This specimen is 30 millimeters long and includes 5 of the lower segments of the siphuncle. The endosiphontube is exposed at its lower end, and it has been cut vertically in such a way as to expose this tube for a length of 24 millimeters. The specimen does not supply any additional information as to the structure of this central part of the tube, but it shows distinct lamination of the calcareous deposits formed on the inner walls of the siphuncle in a direction approximately parallel to the curvature of these walls and at right angles to the more or less radiating fibers mentioned above. This lamination is shown most distinctly along the lower segments of the siphuncle. Traces of the radial fibrous structure also appear. U. S. National Museum, no. 81925.

In a specimen of *Stokesoceras engadinense* Foerste (21) from the Manistique formation at Point aux Barques, 12 miles southwest of Manistique, in northern Michigan, the lower part of the siphuncle shows a funnel-shaped calcareous deposit whose lower end terminates in an endosiphontube showing successive rhythmic stages of elevation of the basal part of these funnel-like deposits. Univ. of Michigan Museum, no. 7552.

One of the specimens figured by Foord (22) under the name *Discosorus gracilis* Foord, from the Manistique of Drummond island, in the northwestern part of Lake Huron, and later referred by Foerste to *Stokesoceras romingeri*, shows a funnel-shaped cavity along the upper part of the siphuncle terminating below in an endosiphuncle. British Museum of Natural History, no. 33424.

Funnel-like cavities occur also in the siphuncles of various species of *Armenoceras*. In one specimen of *Armenoceras magnum* (Parks) (23) this cavity contracts from a diameter of 32 millimeters at the top to 12 millimeters at its base in a length of 115 millimeters. In the holotype of *Armenoceras hearsti* (Parks) the lower end of a funnel-shaped cavity continues downward as an endosiphontube. In *Armenoceras richardsoni* (Stokes) (24) the funnel-shaped cavity frequently is present. However, in all of these specimens close observation will reveal that these structures merely are late stages of development of true annulosi-

phonate types of deposition within the siphuncles, the lamellar deposits being not continuous, but interrupted a little above midheight of the segments of the siphuncle.

Long funnel-shaped cavities at the top of calcareous deposits occur also within the siphuncles of *Nartheoceras crassisiphonatum* (Whiteaves) (25). In these deposits it is possible to detect a radiating fibrous structure perpendicular to the surface of the segments of the siphuncle and fainter traces of lamellar structure parallel to the walls of the funnel-shaped cavity, in this respect simulating the structure of the deposits within the siphuncles of *Discosorus* and *Stokesoceras*. In *Donacoceras* (26) a similar combination of fibrous and lamellar structure appears to exist.

Some specimens of *Huronia* (27) weather in such a manner as to present an appearance of vertical radiating lamellae within the siphuncle, but whether this radiating lamellar structure is connected with the presence of radiating fibrous structure of the calcareous deposits originally occupying their interior can not be determined in the specimens at hand, owing to their silicification without the preservation of their original structure.

#### 45. ENDODISCOSORUS Teichert

Genotype: *Endodiscosorus foerstei* Teichert. On the systematic position of the genus *Discosorus* Hall and related genera; American Museum Novitates, no. 512, p. 10, figs. 8, 9 (1931).

Of the genotype only the lower part of the siphuncle is known. One side of its dorsoventral outline is almost straight; the opposite side is distinctly convex. The segments of this siphuncle rise toward its straight outline, differing in this respect from typical *Discosorus* in which the segments rise toward the convex outline of the siphuncle.

This genotype was found in the Lake Timiskaming area, in the lower part of those Silurian strata identified by G. S. Hume as Lockport. Apparently these strata correspond approximately with the Burnt Bluff or Manistique of Northern Michigan.

**KAYOCERAS** new genus

Genotype: *Kayoceras biconoideum* (Thomas). Proc. Iowa Acad. Sci., vol. 22, p. 298, pl. 34, fig. 1 (1915).

Conch breviconic, moderately inflated, slightly curved, with its ventral outline more convex. Its dorsal outline is convex along the living chamber and the upper half of the phragmacone but may have been slightly concave farther down. The sutures of the septa curve moderately downward laterally and rise slightly higher ventrally than dorsally. The siphuncle is relatively large and is ventrad of the center of the conch but conspicuously distant from its ventral wall. Its segments are nummuloidal, closely arranged, and the septal necks are assumed to have been very short and abruptly curved outward.

Compared with typical *Discosorus*, this genus is distinguished by the remoteness of its siphuncle from the ventral wall of the conch and the consequent small obliquity of its segments. From *Armenoceras* it differs in its cyrtoconic structure.

46. **Kayoceras biconoideum** (Thomas)

Plate 31, figures 1 A, B, C; plate 41, figure 2

1915. *Discosorus* (?) *biconoideus* Thomas. Some unique Niagaran cephalopods; Proc. Iowa Acad. Science, vol. 22, p. 298, pl. 34, fig. 2 (not fig. 1).

The holotype consists of a fragment of a siphuncle 54 millimeters long. According to the orientation of this siphuncle by the present writer, only the ventral and lateral sides are preserved, the median part of its dorsal side being weathered away. The radius of curvature of its convex ventral outline increases from 50 millimeters along its lower half to 130 millimeters farther up. The lateral diameter of the siphuncle increases from 9.5 millimeters at its base to 16.6 millimeters at the fifth segment above its base and then decreases to 12 millimeters at its top. The cross section of the siphuncle is faintly compressed laterally, its dorsoventral diameters being about half a millimeter greater than the lateral ones. Along its ventral outline 11 segments of

the siphuncle occur in a length of 51 millimeters. The lowest segment is 3.5 millimeters long, the next is 4 millimeters, the next two are 4 millimeters long, increasing to 4.5 millimeters in the next six segments, the length of the uppermost segment being 3.5 millimeters. The segments rise in a ventrad direction at an angle of 20 degrees with a plane directly transverse to the central axis of the siphuncle. In consequence the lower 4 or 5 segments expose their lower faces more broadly than their upper ones, but without becoming thinner in a ventrad direction as in typical *Discosorus*. The segments of the siphuncle are nummuloidal, being broadly nummuloidal near midlength of the latter. The septal necks can not have exceeded a fourth of a millimeter in length, their lower margins curving abruptly outward and upward so as to leave a slight depression on the upper side of the nummuloidal segments as preserved in the holotype. The contraction of the diameter of these segments at the septal necks apparently increases from 4 millimeters at the upper and lower ends of the siphuncle to about 6 millimeters at its broadest part. Plate 41, figure 2.

Occurrence: Delaware county, Iowa; exact locality unknown; from the Hopkinton dolomite.

University of Iowa, no. 8-313.

Remarks.—The figure published by Thomas and cited above is a ventral view of the holotype in an inverted direction.

A more complete specimen, from Monmouth, in the southwestern part of Jackson county, Iowa, consists of a considerable part of the right half of the conch. This specimen is 86 millimeters long, 25 millimeters of this length belonging to the living chamber. The conch is relatively erect, both the ventral and the dorsal outlines being gently convex. The radius of curvature of the ventral outline is 250 millimeters along the phragmacone, apparently changing to 100 millimeters along the living chamber. The corresponding radius of curvature of the dorsal outline is 200 millimeters along the phragmacone, changing to 150 millimeters along the living chamber. The dorsoventral diameter enlarges from approximately 35 millimeters 8 camerae below the living chamber to 46 millimeters at the base of this chamber and

then contracts very slightly toward the aperture. The radius of curvature of the vertical lateral outline is 200 millimeters, with a similar slight contraction of the living chamber toward its aperture. The cross section of the conch is approximately circular. Eight camerae occupy a length of 42 millimeters. The sutures of the septa curve downward laterally about 3 or 4 millimeters at the top of the phragmacone, rising 2 or 3 millimeters higher dorsally than ventrally. Nine segments of the siphuncle are exposed on the weathered side of the specimen. These occupy a total length of 42 millimeters along their dorsal outline, the upper two segments of this siphuncle not being preserved. The second segment from the bottom has a dorsoventral diameter of 15 millimeters, this diameter increasing to 18 millimeters at the fifth segment and then decreasing to 16.8 millimeters at the eighth segment and to 15.2 millimeters at the ninth, which is the uppermost segment preserved. At the fifth segment from the base the siphuncle is 4 millimeters distant from the ventral wall of the conch, this distance increasing to 6 millimeters at the upper two segments. The segments are nearly circular in horizontal outline and rise at an angle of 7 degrees in a ventrad direction. Apparently there is room between these segments for little more than the septa. The diameter of the septal neck apparently is 11 millimeters where that of the overlying segment of the siphuncle is 17 millimeters. Plate 31, figs. 1 A, B.

A second specimen from the same locality and horizon retains parts of the upper 7 camerae of the phragmacone. The uppermost camera is 2 millimeters long, the underlying 3 camerae having a total length of 11.6 millimeters. The conch evidently had reached its gerontic stage of growth. At the top of this phragmacone its dorsoventral diameter is 40 millimeters and its lateral one is estimated at approximately the same. Here the diameter of the siphuncle is about 12 millimeters, at least in the present distorted condition of the specimen, the distance of this siphuncle from the ventral wall of the conch being 6 millimeters. The concavity of the septa is 5 millimeters. Owing to its eccentric location within the conch the segments of this siphuncle

rise strongly in a ventrad direction, at about the same rate as in the preceding specimen (Plate 31, fig. 1 C). Both of these Monmouth specimens are from the Hopkinton dolomite, and both are numbered 67054 in the U. S. National Museum.

Occurrence: Provisionally that part of the Hopkinton dolomite containing *Kayoceras* is correlated with the Manistique of Northern Michigan.

Remarks.—In both *Kayoceras biconoideum* and *Kayoceras thomasi* that face of the segments of the siphuncle which here is identified as their upper face has a shallow annular depression about 0.6 millimeter in width in the immediate vicinity of the septal neck. This annular depression is assumed to correspond to the outward flaring lower part of the septal necks of cyrtchoanoidal cephalopods.

#### 47. *Kayoceras thomasi* new species

##### Plate 41, figure 3

1915. *Discosorus* (?) *biconoideus* Thomas. Some unique Niagaran cephalopods; Proc. Iowa Acad. Sci., vol. 22, p. 298, pl. 34, fig. 1 (not fig 2).

The specimen regarded by Thomas as a paratype of his species *Discosorus biconoideus* is similar to the holotype in the relative straightness of the central axis of its siphuncle, in the general form of the segments of this siphuncle and in their obliquity dorso-ventrally. However, the diameter of this siphuncle is considerably greater, and its rate of contraction at its upper end is considerably less.

This second specimen is 42 millimeters long. Only its left side is preserved. Its lowest two segments have a dorsoventral diameter of 22 millimeters. The fourth from the base has a diameter of 21.5 millimeters, the fifth a diameter of 21 millimeters, and the sixth one of 19.6 millimeters, the diameter of the seventh evidently being still shorter though this segment is not preserved well enough for accurate measurement. The height of these seven segments in a direction at right angles to their upper surfaces, in ascending order, is 5.3, 5.0, 5.0, 4.5, 4.3, 3.5,

and 2.5 millimeters. Evidently the conch had reached its gerontic stage of growth. Only the upper part of the siphuncle, where its diameter diminishes, is preserved. The distance between successive segments, in the present condition of the specimen, is 0.3 millimeter. Where the dorsoventral diameter of the segments is 22 millimeters that of the septal necks equals 14 millimeters. The lower part of the septal neck curves outward for a width of fully one millimeter. Forming a shallow annular groove on the upper surface of the underlying segment, in its present condition, beyond which the connecting ring extends for a width of about 3 millimeters. The vertical outline of all segments is evenly rounded and equally exposed.

Occurrence: Delaware county, Iowa, from some unknown locality; from the Hopkinton dolomite.

University of Iowa, no. 8-312.

#### MANDALOCERAS Hyatt

Genotype: *Gomphoceras bohemicum* Barrande. Système silurien du centre de la Bohême, vol. 2, pt. 1, p. 306, pl. 74, figs. 12-16 (1865).

In typical *Mandaloceras*, as indicated by its genotype, the conch is erect, with its ventral outline distinctly but moderately more convex than its dorsal one. The aperture of the living chamber is T-shaped, all parts being narrowly contracted both medially and dorsolaterally. The nummuloid siphuncle is located halfway between the center of the conch and its ventral wall.

The Wilmington species *Mandaloceras austini* evidently is congeneric, but its aperture is poorly indicated.

#### 48. *Mandaloceras austini* new species

*Plate 30, figure 3*

The holotype consists of the living chamber and 6 camerae. Its total length is approximately 93 millimeters, of which 46 millimeters belong to the living chamber. The dorsal outline of the phragmacone has a radius of curvature of 120 millimeters,

changing to 60 millimeters along the living chamber. That of its ventral outline is more nearly uniform, both along the phragmacone and the living chamber, equalling about 90 millimeters. In general this ventral outline appears a little more convex than the dorsal outline taken as a whole. Although the aperture is very poorly preserved enough is retained to show that it was T-shaped, the two dorsal lobes having a total lateral extension of about 20 or 23 millimeters, while the laterally contracted part terminating at the hyponomic sinus had a total extension of 30 millimeters, the lower margin of this sinus being 35 millimeters above the suture at the base of the living chamber. The dorso-ventral diameter of the conch enlarges from 38 millimeters at the base of the sixth camera beneath this chamber to 55 millimeters at the top of the phragmacone, contracting to 35 millimeters at the level of the lower margin of the hyponomic sinus. The uppermost camera is 6 millimeters long, the one immediately beneath having a length of 8 millimeters, the lowest one of the group of six measuring 6 millimeters. In its present condition the conch is compressed laterally, its maximum lateral diameter being estimated at 48 millimeters.

Occurrence: Wilmington, Ohio, from the Moodie quarry; in the Cedarville dolomite.

U. S. National Museum, No. 81852.

Remarks.—This conch is of interest chiefly on account of its resemblance to some of the larger forms of *Mandaloceras* found in the Racine of Wisconsin and northern Illinois.

#### STENOGOMPHOCERAS Foerste

Genotype: *Stenogomphoceras chadwicki* Foerste. Three studies of cephalopods; Jour. Sci. Lab. Denison Univ., vol. 24, p. 367, pl. 61, figs. 2 A, B, C, D (1929). See also Port Byron and other Silurian cephalopods, Jour. Sci. Lab., Denison Univ., vol. 25, p. 118, pl. 24, figs. 1 A-D; 2 A, B; pl. 23, figs. 1 A, B (1930).

Conchs strongly compressed laterally, so that the living chamber appears tall when viewed from its ventral or dorsal side. This chamber usually is more or less distinctly constricted above

midheight, the constriction forming a broad and shallow transverse groove which rises and becomes fainter ventrally. The aperture has a large dorsal lobe and a laterally constricted ventral hyponomic sinus similar to that of *Mandaloceras*. In the genotype the margin of the dorsal lobe is faintly pentalobate. Sutures of the septa usually curve downward laterally.

Species of this genus can be distinguished generically only when the aperture of the living chamber is preserved. However, the specimen here described as *Stenogomphoceras ignotum* is similar in dorsoventral outline to that described as *Stenogomphoceras inflatum* from the Port Byron dolomite at Port Byron in Illinois, differing chiefly in the relatively greater number of its camerae. The affinities of the unnamed species from Wilmington, Ohio, are more uncertain, since the living chamber is not preserved.

49. *Stenogomphoceras* (?) *ignotum* new species

Plate 35, figures 3 A, B

The holotype is about 38 millimeters long. The conch is compressed laterally. The dorsoventral diameter enlarges from 22 millimeters at its base to 32 millimeters a little above the base of the living chamber and then contracts to 26 millimeters at the top of the part preserved. The corresponding lateral diameters are 18, 28, and 22 millimeters. The lateral outlines are symmetrical, but the maximum convexity of the ventral outline is nearer the base of the living chamber while that of the dorsal outline is about 5 millimeters farther up. Moreover, the total length of the 8 camerae preserved equals 20 millimeters along their ventral outline, but only 16.5 millimeters dorsally. The constriction of the upper part of the living chamber is most conspicuous along the upper 5 millimeters of its length. The lower 7 camerae occupy a total length of 18 millimeters, the eighth or uppermost one being conspicuously shorter.

Occurrence: Wilmington, Ohio, from the Moodie quarry; in the Cedarville dolomite.

Wilmington College, in the collection of Dr. L. D. Welch.

Remarks.—The specimen here described resembles *Stenogomphoceras inflatum* Foerste, from the Port Byron dolomite at Port Byron, Illinois, differing from the latter chiefly in the relatively greater number of its camerae.

50. *Stenogomphoceras* (?) sp. (Wilmington)

Plate 32, figures 3 A, B

The holotype consists of part of a phragmacone in which the camerated part is 29 millimeters long, a single segment of the siphuncle projecting above the latter for an additional length of 2 millimeters. The dorsal and ventral outlines of this phragmacone are essentially straight, the concavity of its dorsal outline being almost imperceptible. The conch is strongly compressed laterally, its dorsoventral diameter enlarging from 14 millimeters at its base to 24 millimeters at its top, the corresponding lateral diameters being 13 and 21 millimeters. Twelve camerae are preserved, 10 of these occurring within a length equal to the dorsoventral diameter when counted along the dorsal outline. The sutures of the septa curve downward laterally, their downward curvature equalling 0.6 millimeter at the top of the specimen. This downward curvature is not shown in fig. 3A on pl. 32, owing to a slight tilting of the specimen while photographing. At mid-height of the specimen the segments of its siphuncle are about 3.5 millimeters in diameter and 2.5 millimeters in height, their structure being nummuloidal, but without conspicuous width. The diameter of the septal necks is estimated at 1.5 millimeters but this part is not clearly exposed. The uppermost segment is 5.5 millimeters in diameter. The distance of the siphuncle from the ventral wall of the conch is about 0.6 millimeter. Only a cast of the interior of the conch is preserved and this shows no trace of ornamentation of the surface of the shell.

Occurrence: Wilmington, Ohio; from the Moodie quarry; in the Cedarville dolomite.

U. S. National Museum, no. 81926.

Remarks.—This phragmacone resembles *Stenogomphoceras* in its erect form, lateral compression, and in the location of its

siphuncle, but the segments of its siphuncle are distinctly nummuloidal, while the form of the corresponding segments in typical *Stenogomphoceras* is unknown.

51. *Wilsonoceras mccharlesi* (Whiteaves)

Plate 42, figure 1

1889. *Trochoceras McCharlesi* Whiteaves. Trans. Royal Soc. Canada, vol. 7, sec. 4, p. 81, pl. 16, figs. 1, 2.

1889. *Apsidoceras insigne* Whiteaves. *ibid.*, p. 82, pl. 17, figs. 1, 2.

1929. *Wilsonoceras mccharlesi* Foerste. Denison Univ. Bull., Jour. Sci. Lab., vol. 24, p. 180, pls. 19, 20, 23, 39 (1929).

The figure presented on plate 23 of volume 29 of the Denison University Bulletin, cited above, is two fifths of the natural size of the paratype. A crack passing diagonally downward across the phragmacone terminates slightly toward the right of the middle of the base of this figure. The cross section of the outer volution presented along the lower part of this crack is indicated by figure 3 on plate 39 of the same volume. At this point the siphuncle is located at a point one third of the dorsoventral diameter of the conch from its concave dorsal outline. At the time this cross section was drawn the siphuncle was exposed at one of the septal necks. Later, that part of the outer volution immediately left of the crack mentioned above was sectioned dorsoventrally through the center of the siphuncle at the National Museum of Canada. This section reveals that the siphuncle consists of a series of conspicuous nummuloidal segments, strongly contracted at the septal necks. These necks are relatively long, somewhat as in typical species of *Actinoceras*.

Occurrence: Tyndall, Manitoba; in the Selkirk member of the Red River formation.

National Museum of Canada, no. 6018.

Remarks.—In the specimen here discussed the two outer volutions of the phragmacone are in light contact with each other. *Apsidoceras insigne* apparently belongs to the same genus but it is not certain that it belongs to the same species.

The species of *Wilsonoceras* described by A. K. Miller from the Big Horn formation of Wyoming are gyroceraconic.

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# PLATE 29

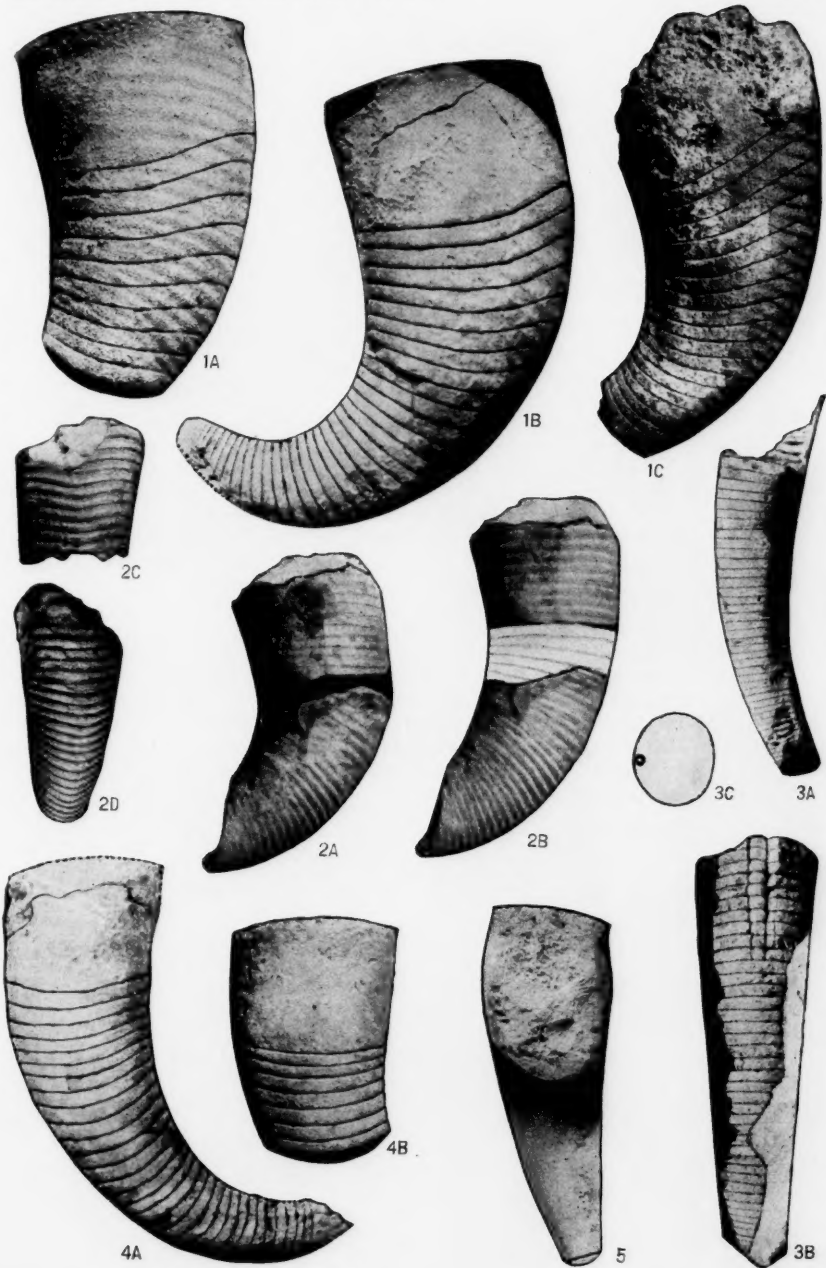
Fig. 1. *Cyrtorizoceras falciforme* Foerste. A, lateral view, with transverse ribs distinct ventrally but becoming faint in a dorsal direction. B, with ribs faint and restricted to the ventral side. C, with annulations more distinct ventrally. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. A, B, from the Welch collection; C, from the Austin collection in U. S. N. M., no. 82172 A. Cotypes.

Fig. 2. *Cyrtorizoceras lucillum* (Hall). A, two fragments forming the holotype, probably not parts of the same individual. B, an attempt to orient the latter correctly. C, ventral view of the upper fragment. D, ventral view of the lower fragment. Wauwatosa, Wisconsin; in the Racine dolomite. American Museum of Natural History, no. 2120, holotype.

Fig. 3. *Galtoceras arcticameratum* (Hall). A, Lateral view with ventral side on left. B, ventral view with siphuncle exposed at upper end; C, cross section showing location of siphuncle. Galt, Ontario, Canada; in the Guelph dolomite. American Museum of Natural History, no. 2236, cotypes.

Fig. 4. *Cyrtorizoceras fosteri* (Hall). A, Lateral view of a nearly complete specimen, but not retaining the top of the living chamber. B, another specimen retaining more of the living chamber. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. A, from the Welch collection; B, from the Austin collection in the U. S. National Museum, no. 82171 B.

Fig. 5. *Cyrtorizoceras cedarvillense* Foerste. Lateral view with ventral outline on left; its upper half includes a cast of the interior of the living chamber; its lower half consists of an impression left by the phragmacone in the matrix. Cedarville, Ohio; in the Cedarville dolomite. Holotype, U. S. National Museum, no. 81924.



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### PLATE XXX

Fig. 1. *Uranoceras* (?) *perdistensum* Foerste. Lateral view including a considerable part of the living chamber. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. From the Austin collection in the U. S. National Museum, no. 89823; holotype.

Fig. 2. *Anomeioceras percurvatum* Foerste. A, lateral view of living chamber; B, ventral view of same, the left side of this chamber as figured being missing. Yellow Springs, Ohio; from the Cedarville dolomite. Ohio State University, no. 3411; holotype.

Fig. 3. *Mandaloceras austini* Foerste. Lateral view, with ventral outline on right. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. From the Austin collection in the U. S. National Museum, no. 81852; holotype.

Fig. 4. *Worthenoceras subfusiforme* Foerste. A, dorsal view, imperfect along the lower part of its left margin. B, lateral view with ventral margin on right. C, upper part of ventral side, showing the distinct hyponomic sinus. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. From the Austin collection, in the U. S. National Museum, no. 89818 A; holotype. See also pl. 37, fig. 2.



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PLATE XXXI

Fig. 1. *Kayoceras biconoideum* (Thomas). A, lateral view with ventral outline on right, exposing 3 segments of the siphuncle at its base. B, opposite side of same specimen weathered so as to expose the siphuncle. C, top of phragmacone of another specimen showing the location of the siphuncle on the ventral side of the conch but not in contact with the latter. Monmouth, Iowa; probably from the lower part of the Hopkinton dolomite. U. S. National Museum, no. 67054.

Fig. 2. *Grimbyoceras hillsboroense* Foerste. A, ventral view with traces of 4 sutures of septa along its upper part, and transversely striated along its middle and lower parts. B, lateral view with ventral outline on left, showing sutures of 5 septa from this point of view. Trimble quarry, in northeast margin of Hillsboro, Ohio; from the lower part of the Peebles dolomite. U. S. National Museum, no. 81931 A. See also pl. 36, figs. 4 A, B. Holotype.

Fig. 3. *Grimbyoceras hillsboroense* Foerste. Lateral view, imperfectly preserved both along its ventral and dorsal outlines; matrix at top apparently preserving a trace of the form of the lower part of the animal when fully exerted. From same locality and horizon as the holotype. U. S. National Museum, no. 81931 B.



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PLATE XXXII

Fig. 1. *Grimsbyoceras genuiflexum* Foerste. A, dorsal view; B, lateral view with ventral outline on right; C, ventral view. The downward sloping transverse lines apparently represent transverse striae on the surface of the shell. Hillsboro, Ohio; in the lower part of the Peebles dolomite. Ohio State Univ., no. 5903, holotype.

Fig. 2. *Grimsbyoceras genuiflexum* Foerste. A, lateral view with ventral outline on right; B, top of specimen viewed from above; C, ventral view. The matrix at the top of the specimen, within the interior of the living chamber, is contracted, possibly in conformity with the general shape of the lower part of the animal when fully exerted. Hillsboro, Ohio; in the lower part of the Peebles dolomite. Ohio State University, no. 9888, paratype.

Fig. 3. *Stenogomphoceras* (?) sp. A, lateral view with top of siphuncle projecting above its right side; B, ventral view, exposing the siphuncle also along its lower half. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. From the Austin collection in the U. S. National Museum, no. 81926.

Fig. 4. *Ectocyrtoceras* (?) *gibberosum* Foerste. A, lateral view, with ventral outline on left; B, ventral view, outline on right not preserved. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. From the Austin collection in the U. S. National Museum, no. 89822, holotype.



1A



1B



1C



2A



2B



2C



3A



3B



4A



4B

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PLATE XXXIII

Fig. 1. *Ectocyrtoceras* (?) *wilmingtonense* Foerste. A, ventral view; B, lateral view with ventral outline on right. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. From the Austin collection in the U. S. National Museum, no. 89821 A, holotype.

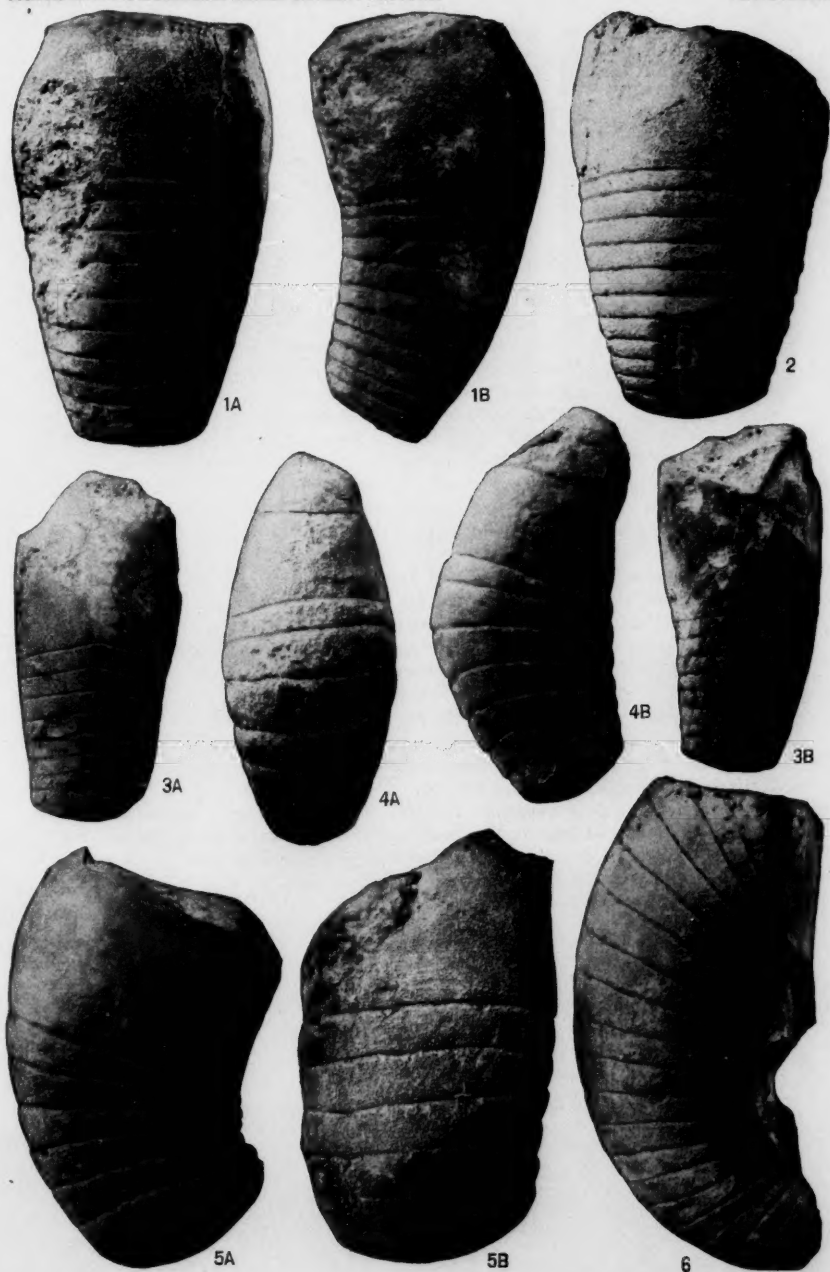
Fig. 2. *Ectocyrtoceras* (?) *wilmingtonense* Foerste. Ventral view, cut at base to expose the siphuncle. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. From the Austin collection in the U. S. National Museum, no. 89821 B, paratype.

Fig. 3. *Euryrizoceras anguloseptatum* Foerste. A, ventral view, with septa angulate along median line; B, lateral view with ventral outline on right. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. From the Austin collection in the U. S. National Museum, no. 81925, holotype.

Fig. 4. *Austinoceras turgidulum* Foerste. A, ventral view; B, lateral view with ventral outline on left. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. From the Austin collection in the U. S. National Museum, no. 89819, holotype.

Fig. 5. *Euryrizoceras percurvatum* Foerste. A, lateral view with ventral outline on left; B, ventral view, with outline on left weathered away. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. From the Austin collection in the U. S. National Museum, no. 89820 A.

Fig. 6. *Euryrizoceras percurvatum* Foerste. Lateral view with ventral outline on left. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. From the Austin collection in the U. S. National Museum, no. 89820 B.



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PLATE XXXIV

Fig. 1. *Discosorus austini* Foerste. A, ventral view exposing the siphuncle and retaining 35 millimeters of the lower part of the living chamber. B, lateral view exposing only the ventral side of the specimen, its dorsal part still being imbedded within the matrix. Todd's Fork, 2 miles north of Wilmington, Ohio; in the Dayton limestone member of the Clinton group. From the Austin collection in the U. S. National Museum, no. 89824, holotype.

Fig. 2. *Discosorus lyonsense* Foerste. A, lateral view with ventral outline on left; B, ventral view. Lyons, Iowa, 4 miles north of Clinton; probably from the lower part of the Hopkinton dolomite. U. S. National Museum, no. 7786, holotype.

Fig. 3. *Byronoceras* (?) *radiciforme* Foerste. A, lateral view with ventral outline on left; B, ventral view. Moodie quarry, Wilmington, Ohio; from the Cedarville dolomite. Ohio State University, no. 14805, holotype.

Fig. 4. *Discosorus austini* Foerste. A, lateral view of the upper part of a siphuncle, with its ventral outline on the right; left margin not preserved. B, ventral view of the same, only the left half preserved. C, vertical dorsoventral section, with its ventral outline on the left; its dorsal outline partially restored. About half a mile northeast of the Osman school, which is 5 miles east of West Union, Ohio; from the Dayton limestone member of the Clinton group. U. S. National Museum, no. 81821 A, paratype. See also pl. 35, fig. 5.

Fig. 5. *Discosorus perexpansum* Foerste. A, ventral view of siphuncle, tilted to show the flattened area on the basal part of its ventral side; B, lateral view with ventral outline on left, the dorsal outline not being preserved. Centerville, Ohio; in the Dayton limestone member of the Clinton group. U. S. National Museum, no. 81923, holotype.



PLATE XXXV

Fig. 1. *Amphicyrtoceras orcas latum* Foerste. Lower part of the ventral side of the conch, its upper part not being preserved; showing broad transverse striations and narrower vertical lines, the latter being confined apparently to the inner layers of the shell. Racine, Wisconsin; in the Racine dolomite. Illinois State Museum, no. 8381, holotype.

Fig. 2. *Worthenoceras racinense* Foerste. Dorsal view, restored along its upper right and lower left outlines. Racine, Wisconsin; from the Racine dolomite. Illinois State Museum, no. 8382 D, holotype. See also pl. 38, figs. 2 A, B.

Fig. 3. *Stenogomphoceras ignotum* Foerste. A, ventral view; B, lateral view with ventral outline on left. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. From the Welch collection. Holotype.

Fig. 4. *Amphicyrtoceras welchi* Foerste. A, ventral view; B, lateral view with ventral outline on left. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. From the Welch collection. Holotype.

Fig. 5. *Discosorus austini* Foerste. Diagrammatic restoration of the specimen illustrated by fig. 4 C, on pl. 34.



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PLATE XXXVI

Fig. 1. *Ekwanoceras* (?) *austini* Foerste. A, ventral view showing groove below margin of aperture on east of interior of living chamber; B, lateral view with ventral outline on right. Moodie quarry, Wilmington, Ohio; from the Cedarville dolomite. In the Welch collection. Holotype.

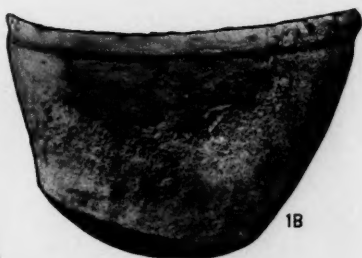
Fig. 2. *Amphicyrtoceras bownockeri* Foerste. Lateral view of east of interior of conch with ventral outline on right; at the top of the living chamber the matrix is contracted in a way suggesting that it outlined the form of the lower part of the animal when fully exerted. Trimble quarry, in northeastern margin of Hillsboro, Ohio; in the lower part of the Peebles dolomite. U. S. National Museum, no. 81827 D. See also pl. 37, figs. 1 A, B, C.

Fig. 3. *Amphicyrtoceras reedsi* Foerste. A, lateral view with ventral outline on left; B, ventral view, exposing the siphuncle in upper three camerae; C, dorsal view. Waukesha, Wisconsin; in the Racine dolomite. American Museum of Natural History, no. 2112 B. Holotype.

Fig. 4. *Grimsbyoceras hillsboroense* Foerste. A, dorsal view with 5 sutures of septa along the upper part of the phragmacone; the contraction of the upper part of the living chamber at the aperture is overaccentuated from this point of view. B, ventral view, showing both the sutures of the upper septa and the transverse striae on the surface of the shell along the lower part of the specimen. Hillsboro, Ohio; in the lower part of the Peebles dolomite. U. S. National Museum, no. 81931 A. See also pl. 31, figs. 2A, B; 3. Holotype.



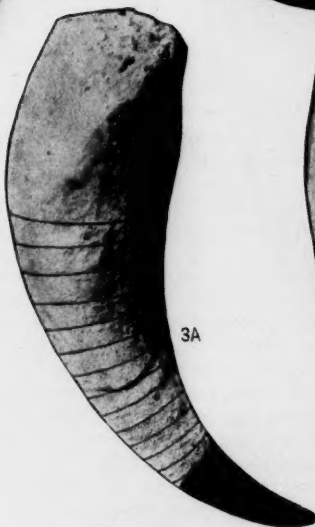
1A



1B



2



3A



3B



4A



4B



3C

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# PLATE XXXVII

Fig. 1. *Amphicyrtoceras bownockeri* Foerste. A, dorsal view of holotype, with a few transverse striae at midlength. B, ventral view of paratype with transverse striae curving slightly downward along its median part; at its top the matrix within the interior of the living chamber is contracted as in fig. 2 on pl. H. C, lateral view with ventral outline on left. Trimble quarry, along northeastern margin of Hillsboro, Ohio; in the lower part of the Pebbles dolomite. U. S. National Museum, three specimens, numbered 81827 A, B, C in the order here figured.

Fig. 2. *Worthenoceras* (?) *subfusiforme* Foerste. Dorsal view showing a slight downward curvature of the transverse striae along its median part. Moodie quarry, Wilmington, Ohio; from the Cedarville dolomite. U. S. National Museum, no. 89818 B. See also pl. 30, figs. 4 A, B, C.

Fig. 3. *Amphicyrtoceras williamsi* Foerste. A, lateral view of holotype, with ventral outline on right, exposing dorsal side of segments of siphuncle, their ventral parts having weathered away. B, living chamber of another specimen. C, upper part of phragmacone of a third specimen. Warton, Bruce peninsula, 6 miles northwest of Owen sound, Georgian Bay, Ontario, Canada in the Guelph dolomite. National Museum of Canada, nos. 5134, 5133, 5133a, in the order here figured. See also Silurian Geology and Faunas of Ontario Peninsula, and Manitoulin and adjacent islands, by M. Y. Williams, Mem. 111, Geol. Surv. Canada, pl. 26, figs. 4, 2, 3, 1919.

Fig. 4. *Discosorus austini* Foerste. Siphuncle strongly weathered, with a trace of the endosiphontube at its base. From the Osman school, 5 miles east of West Union, Ohio, an eighth of a mile east and half a mile northeast along an abandoned road; in the Dayton limestone member of the Clinton group. U. S. National Museum, no. 81922.



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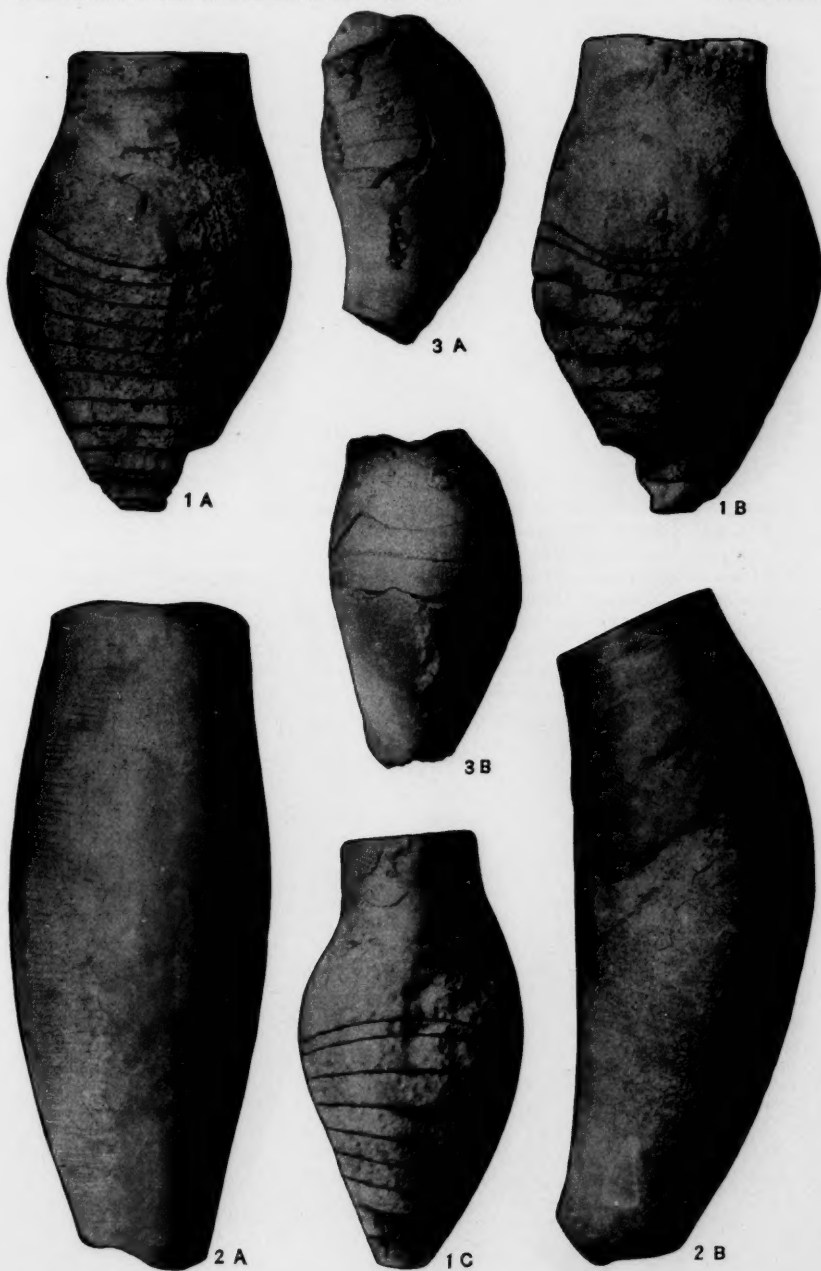
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PLATE XXXVIII

Fig. 1. *Rhomboceras welchi* Foerste. A, dorsal view with upper half of living chamber restored, its left margin being distinctly outlined as far as the aperture; B, ventral side with only the upper left corner of the living chamber restored; C, lateral view with ventral outline on right, the upper part of the dorsal outline of the living chamber restored. Moodie quarry, Wilmington, Ohio; in the Cedarville dolomite. In the Welch collection. Holotype.

Fig. 2. *Worthenoceras racinense* Foerste. A, ventral view, restored along its right margin. B, lateral view, with ventral outline on right. Racine, Wisconsin; in the Racine dolomite. Illinois State Museum, no. 8382 D; holotype. See also pl. 35, fig. 2.

Fig. 3. *Amphicyrtoceras grimsbyense* Foerste. A, lateral view, with ventral outline on right; B, slightly oblique ventral view, with trace of hyponomic sinus at aperture. Grimsby, Ontario, from the upper part of the Lockport dolomite. National Museum of Canada, no. 2744c. Holotype. Original of fig. 26 on page 86 of Cat. Sil. Foss. Anticosti, Geol. Surv. Canada, 1866.



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PLATE XXXIX

Fig. 1. *Ectocyrtoceras thales* (Billings). A, ventral view; B, lateral view, with ventral outline on left. Grimsby, Ontario; in upper part of Lockport dolomite. National Museum of Canada, no. 2746. Neotype.

Fig. 2. *Amphicyrtoceras pettiti* (Billings). A, dorsal view; B, lateral view, with ventral outline on right. Grimsby, Ontario; from the upper part of the Lockport. National Museum of Canada, no. 2744. One of series of cotypes.

Fig. 3. *Grimsbyoceras corydon* (Billings). A, Diagonal ventral view, showing a single segment of the siphuncle at the top of the phragmacone; B, lateral view, with ventral outline on right; C, ventral view oriented so as to show the rate of enlargement of its phragmacone. Grimsby, Ontario, Canada; in the upper part of the Lockport dolomite. National Museum of Canada, no. 2740; holotype.



1 A



3 A



1 B



3 B



2 A



3 C



2 B

PLATE XL

Fig. 1. *Ectocyrtoceras billingsi* Foerste. A, lateral view of living chamber with ventral outline on right, a single segment of the siphuncle projecting from its base; B, ventral view; C, septum at its base viewed from beneath, and showing the single segment of the siphuncle. Grimsby, Ontario, Canada; in the upper part of the Lockport dolomite. National Museum of Canada, no. 2749. Holotype.

Fig. 2. *Grimsbyoceras clitus* (Billings). A, lateral view with ventral outline on right; B, ventral view, slightly oblique. Grimsby, Ontario, Canada; in the upper part of the Lockport dolomite. National Museum of Canada, no. 2739. Holotype.

Fig. 3. *Grimsbyoceras teucer* (Billings). A, lateral view, with ventral outline on right; B, ventral view, slightly oblique, with faint indication of hyponomic sinus at aperture. Grimsby, Ontario, Canada; in the upper part of the Lockport dolomite. National Museum of Canada, no. 2745. Holotype.

Fig. 4. *Grimsbyoceras* (?) *orodes* (Billings). A, ventral view; B, lateral view of same, with sutures of septa curving distinctly downward laterally. Hespeler, formerly called New Hope, 4 miles north of Galt, Ontario, Canada, in the Guelph dolomite. National Museum of Canada, no. 2921. Holotype. See also Palaeozoic Fossils, Geol. Surv. Canada, vol. 3, pt. 2, pl. 14, figs. 7, 7a, 1895.

Fig. 5. *Cyrtorizoceras williamsi* Foerste. Lateral view, with ventral outline on right. Cape Hurd, at northern end of Bruce peninsula, west of Georgian Bay, Ontario, Canada; in the Guelph dolomite. National Museum of Canada, no. 5136. Holotype.



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PLATE XLI

Fig. 1. *Streptoceras heros* Billings. A, ventral view, with deep hyponomic sinus at top, the upper part of the shell weathered back for a distance of about 8 millimeters beneath the margin of the aperture; transverse striae stronger at rhythmic intervals, as though faintly banded. B, lateral view with ventral outline on right, with slight outward curvature of this outline just beneath the hyponomic sinus. Grimsby, Ontario, Canada; in the upper part of the Lockport dolomite. National Museum of Canada, no. 2747. Holotype.

Fig. 2. *Kayoceras biconoideum* (Thomas). Lateral view with ventral outline on left, the dorsal outline not being preserved. For ventral view see Proc., Iowa Acad. Science, vol. 22, pl. 34, fig. 2, but this figure is printed inverted. Delaware county, Iowa, exact locality unknown; from the Hopkinton dolomite. Univ. of Iowa, no. 8-313. Holotype.

Fig. 3. *Kayoceras thomasi* Foerste. Lateral view with ventral outline on left. Same as Proc. Iowa Acad. Science, vol. 22, pl. 34, fig. 1. Delaware county, Iowa, exact locality unknown; from the Hopkinton dolomite. Univ. of Iowa, no. 8-312. Holotype.



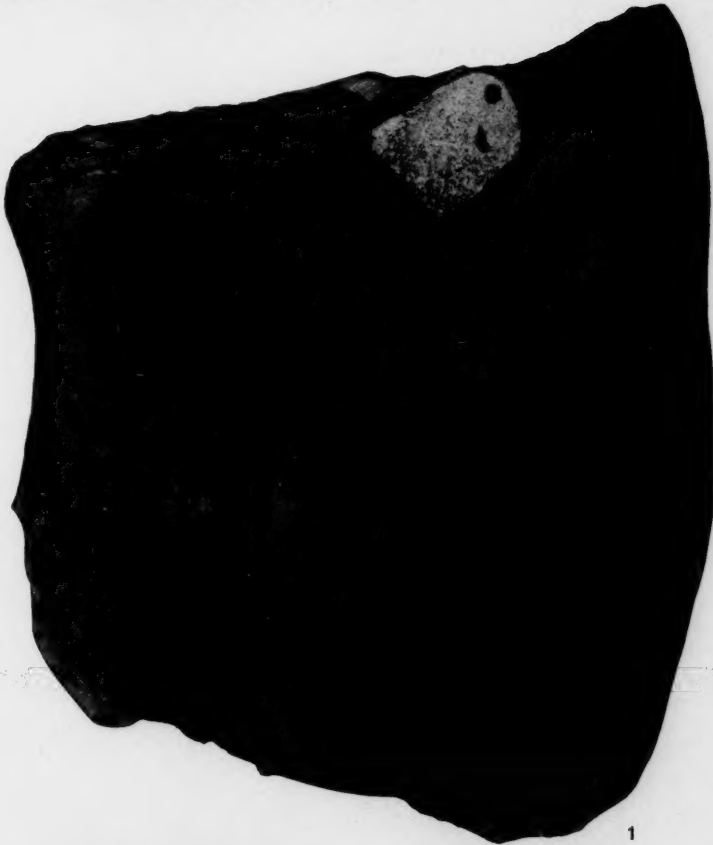
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PLATE XLII

Fig. 1. *Wilsonoceras mccharlesi* (Whiteaves). Dorsoventral section of part of the outer volution of the phragmacone of the specimen figured in Denison Univ. Bull., vol. 29, pl. 23, in 1929. Tyndall, Manitoba; in the Selkirk member of the Red River formation. National Museum of Canada, no. 6018.

Fig. 2. *Discosorus cf. ehlersi* Foerste. Lateral view showing curvature and rate of enlargement of siphuncle, also large size of the latter compared with dorsoventral diameter of conch; B, dorsolateral view of same showing concavity of septa. Same as *Discosorus conoideus* Whitfield, Geol. Wisconsin, vol. 4, pl. 20, fig. 6, 1882. From the railroad cut in section 2 at Ashford, Fond du Lac county, Wisconsin; in the Lower Coral beds of the Niagara Group, correlated by T. C. Chamberlin with the lower part of the Waukesha formation. Museum of Univ. of Wisconsin.



1



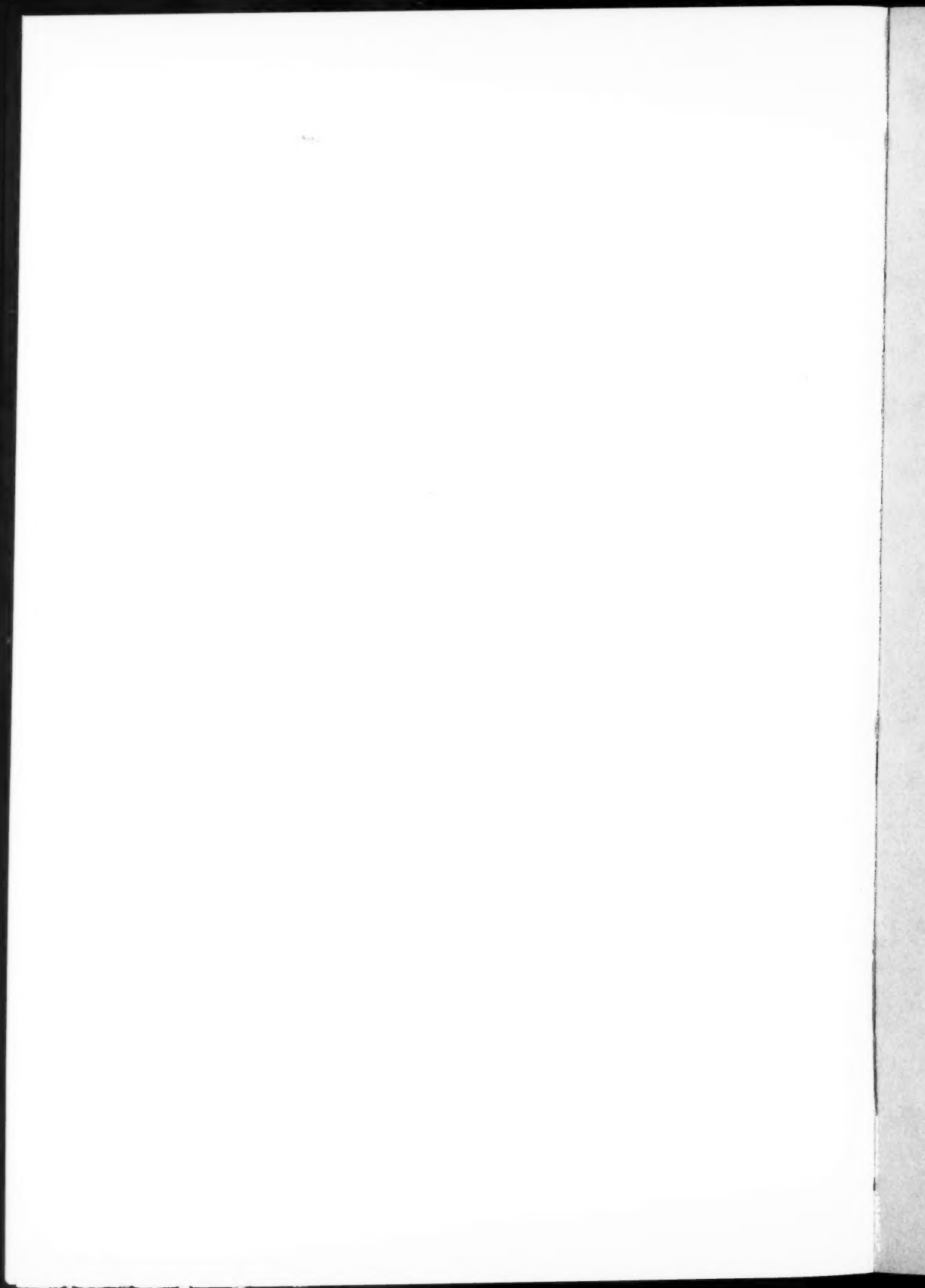
2A



2B

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